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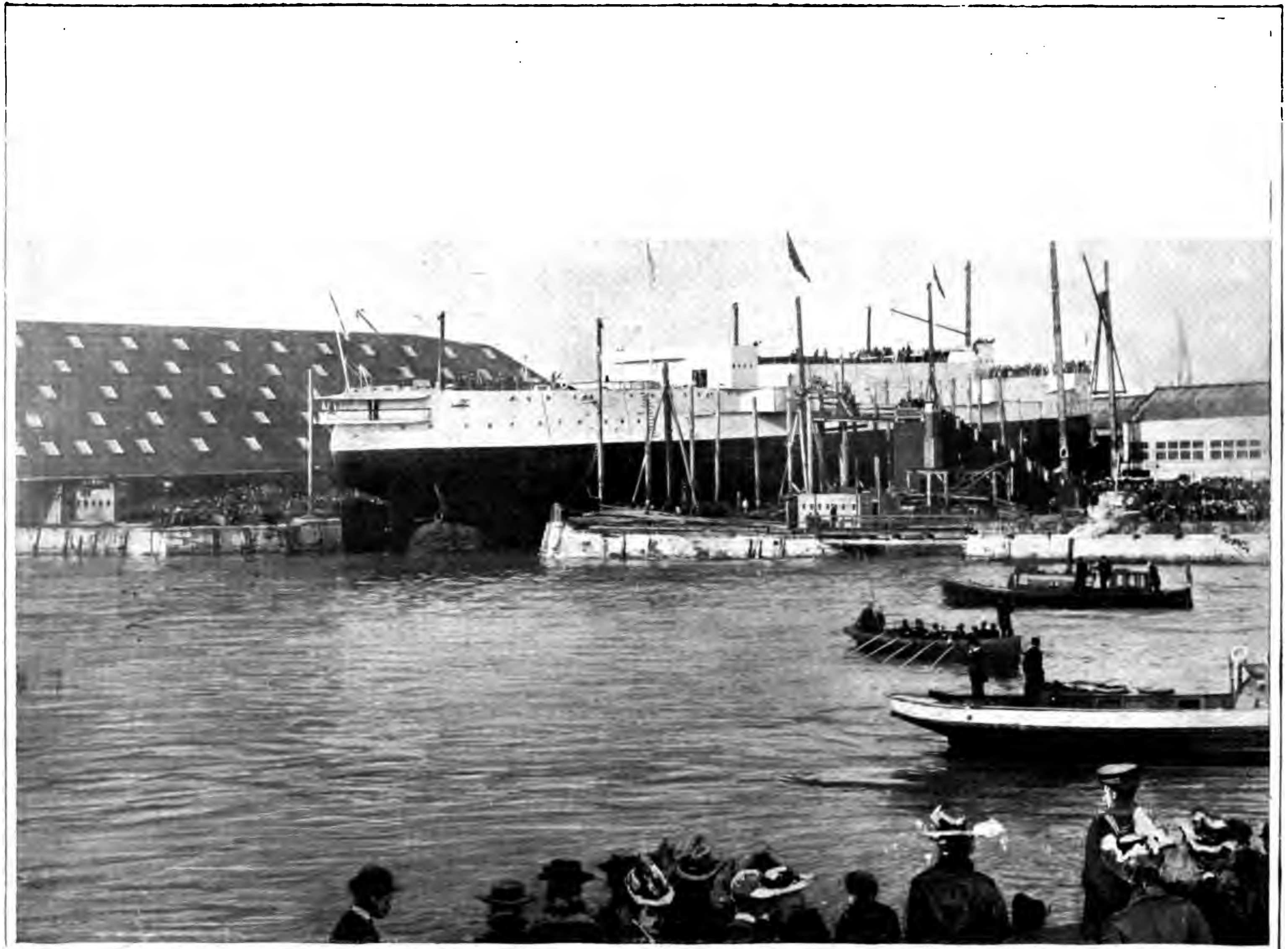


Photo: W. M. Crockett, Plymouth.

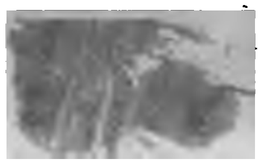
LAUNCH OF A BATTLESHIP FROM DEVONPORT DOCKYARD

BRITAIN AT WORK

A PICTORIAL DESCRIPTION OF OUR NATIONAL INDUSTRIES

ILLUSTRATED FROM PHOTOGRAPHS, ETC.

CASSELL AND COMPANY, LIMITED
London, Paris, New York & Melbourne. MCMII



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INTRODUCTION.

THOUGH Britain is the greatest hive of industry in the World, it is curious how little the average Briton knows of the primary sources of the Nation's Greatness—her Industries. We supply the World's Markets with every commodity required by man, but comparatively few of the forty-one millions of inhabitants of the British Isles possess any definite knowledge of the Wonders of Art and Craft which are to be found in every workshop and factory throughout our own country. This being the case, we are assured that "BRITAIN AT WORK," which tells for the first time in popular form the deeply interesting story of our Industrial Life, will receive an appreciative welcome from all who have at heart the well-being and prosperity of the Nation.

Many of the secrets of Britain's success and of her almost inexhaustible wealth will be revealed in the pages of "BRITAIN AT WORK." For us the gates of her world-famous manufactories will be opened, and at our leisure we may examine the master-pieces of her great Industries. We shall watch the building of a man-of-war from the time of "laying down" until that impressive moment when, casting off its fetters, it floats majestically upon river or sea. Later we shall see the making of the Nation's guns, and in the great Shipbuilding yards of the country witness the growth of the ocean monarchs which will maintain for Britain the Commercial Supremacy of the World.

The miner in the depths of the coal pit will claim our attention. We shall accompany him on his dangerous quest for the fuel which "moves the world," and, having seen it wrested from the earth, we shall ascend with it to the pit-mouth, and follow its journey by rail and sea to the workshop and fireside. After Coal, the great Iron and Steel Industries will pass in review before us, and an opportunity will be afforded of learning at first-hand many valuable facts relative to the wonderful processes of their manufacture.

Remembering the wealth invested in the Land, we shall follow with interest the various operations necessary for the successful cultivation of the soil. The picturesque scenes of rural Britain will be portrayed for us, and the work of ploughing, sowing, and harvesting will be described in a manner that cannot fail to awaken a deeper and more intelligent interest in the Agricultural pursuits of this Country. We shall visit a seed farm, and, in due course, watch the cultivation of flowers, vegetables, and fruit for market.

The busy hives of Belfast, Manchester, and Bradford will be visited, and the manufacture of Linen, Cotton, and Worsted will be seen in operation. We shall also visit the famous Granite quarries of Aberdeen and the Potteries, and in each case an expert writer will explain the processes of these interesting industries.

The realism of the Iron Road will be pictured for us by pen, pencil, and camera, and the everyday life of the railway engine-driver and the signalman vividly described. In a similar manner the daily routine of life in the Navy and Army —industries in the widest sense — will be dealt with, and numerous illustrations depicting the various scenes will help to render the articles of more than passing interest and value.

The wonderful work of the Postal and Telegraph service will find a place in our pages. We shall follow the adventures of a letter from the time it is posted in London until it is delivered in far-away Shetland, and a telegraphic message will be traced from the heart of the City until the great electric cable is lost to view in the depths of the Atlantic Ocean off the coast of Ireland.

We shall make our home for a time with the heroes of the Sea who brave a hundred dangers—even death itself—in their quest for the fish required to meet the ever-increasing demand of our great towns. We shall travel pleasantly along the waterways of Britain—by river and canal—learning the while something of the bargeman's work, and of his everyday life. In this way the marvellous panorama of the Pool of London will be seen to advantage, and many interesting glimpses of industrial life on the busy Thames revealed to us. The great Docks of London, Liverpool, and Southampton, of which the Nation is justly proud, will be visited, and their principal characteristics described and illustrated.

The interesting work connected with the Tea, Coffee, and Cocoa Industries in this country will be popularly explained, and in the same manner we shall learn a great deal about the famous Breweries and Distilleries and the manufactories of Mineral Waters. An article on the Cattle trade will tell how our principal cities are provided with fresh meat day by day, and accounts of the manufacture of Bread, Butter, and Cheese will afford an opportunity of ascertaining the extent and nature of these industrial occupations. Amongst other things we shall see how Paper is made, and afterwards watch its transformation into our daily newspaper or favourite periodical.

Every aspect of our Industrial Life will be sympathetically described, and the scenes as we see them faithfully pictured. Writers pre-eminent in their respective departments have contributed to the work, and every care has been taken to ensure an accurate and instructive account of the industries of our own country. To this end many of the great employers of labour, the heads of our famous manufactories, and the workers themselves have willingly given their valuable assistance, and to one and all our sincere thanks are due.

Never was there a time when it behoved our people to be more alert and active in meeting competition, and we trust that the issue of this work may create such a wide-spread public interest in our Industries, both large and small, that it may not be without its use in quickening the pulses of our Commercial life, and in a small measure may render some service to the Nation at large.

THE BUILDING OF A BATTLESHIP.

NO industry in the British Isles is of greater importance to the nation than that which is concerned with the construction of war-ships. In ordinary times this industry engages the attention of two classes of establishments. There are, first, the Royal Dockyards, which build nothing else but war-ships. There are, secondly, the great private yards, which in some cases specialise upon the construction of vessels for warlike purposes; and in other cases occasionally undertake the building of cruisers or battleships when there is no other work going. In emergencies, such as a great naval war would bring forth, all these sources could be supplemented by the yards which in ordinary times build nothing but steamers for the mercantile marine.

What exactly is the number of the population which is in ordinary times supported by work done in the building of war-ships is difficult to determine. There are no statistics distinguishing between those who derive their daily bread from building merchantmen and those who live upon the wages won in war-ship construction. Most private firms undertake both classes of work at the same time, the only exception being the Royal Dockyards. Moreover, scattered all over the country, there are a vast number of subsidiary industries, all concerned with the war-ship, such as the armour-plate makers at Sheffield and Glasgow, and the various engineering firms who manufacture the hydraulic and electric fittings so largely required on board. It is certainly an underestimate to place the number of men interested directly or indirectly in the manufacture of material for the Navy in Britain at somewhere about a million. The

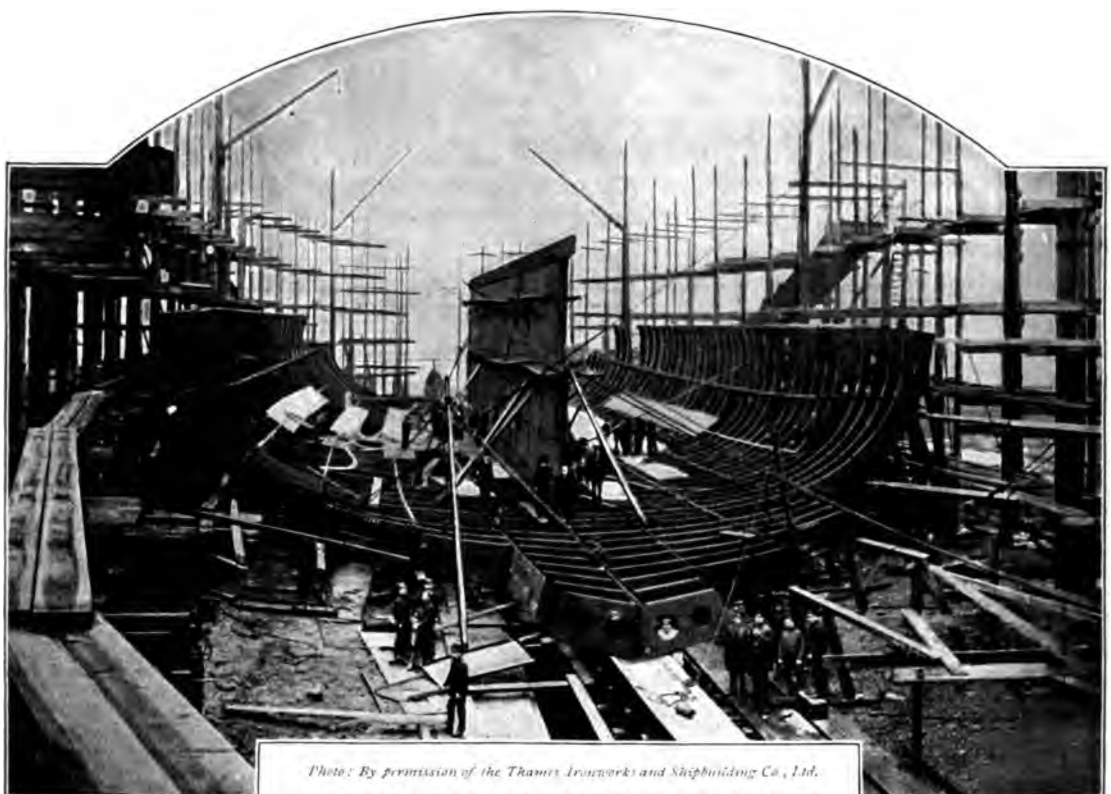


Photo: By permission of the Thames Ironworks and Shipbuilding Co., Ltd.

AN EARLY STAGE IN THE CONSTRUCTION OF A BATTLESHIP, SHOWING KEEL PLATE, FRAMES, AND THE CENTRAL LONGITUDINAL BULKHEAD.

expenditure upon the construction of ships for our Navy alone has been £9,000,000 in one year. But, besides ships for our fleet, vessels were building at the same time for Japan, Holland, and Norway.

The great Government yards are four in number. Portsmouth is the most important, employing 8,000 men; then come Devonport and Chatham, each with 6,900; while Pembroke with 2,400 is a bad fourth. Sheerness with 2,000 men does not build battleships, but only small cruisers and sloops. Round our coasts are scattered a number of private firms who build large war-ships. In London there is the Thames Ironworks, which constructed the first ironclad to figure in our Navy, the old *Warrior*. On the East coast we have the yard of Messrs. Earle, which in the past had a fine record, building small battleships for foreign navies and cruisers for our own. At Sunderland is Messrs. Doxford's yard, which up to the present has constructed only destroyers and merchant steamers, but which could perfectly well build armoured ships. On the Tyne is the gigantic Elswick establishment, where everything for the war-ship, from the hull itself to the guns, projectiles, and even armour, can now be turned out. This firm is one of the largest private builders of war-vessels in the British Isles, and could construct simultaneously two or three battleships and two of the largest armoured cruisers. Close at hand to Elswick is Messrs. Palmer's yard at Jarrow, where the very largest battleships have been constructed for the Navy On the East coast of Scotland there is no firm building big ships; but it is quite otherwise on the West coast, where the Clyde rings with the sound of driving rivets. Here are the immense yards controlled by the armour- and gun-making firms of Brown and Vickers, the first owning the Clydebank Engineering and Shipbuilding Company, and the second the Beardmore yard. Besides these two concerns there are the Fairfield and the London and Glasgow yards, both of which build the largest war-ships.

Descending the coast, there is at Belfast the very important yard of Harland and Wolff, which does not in ordinary times turn out men-of-war, but which is quite

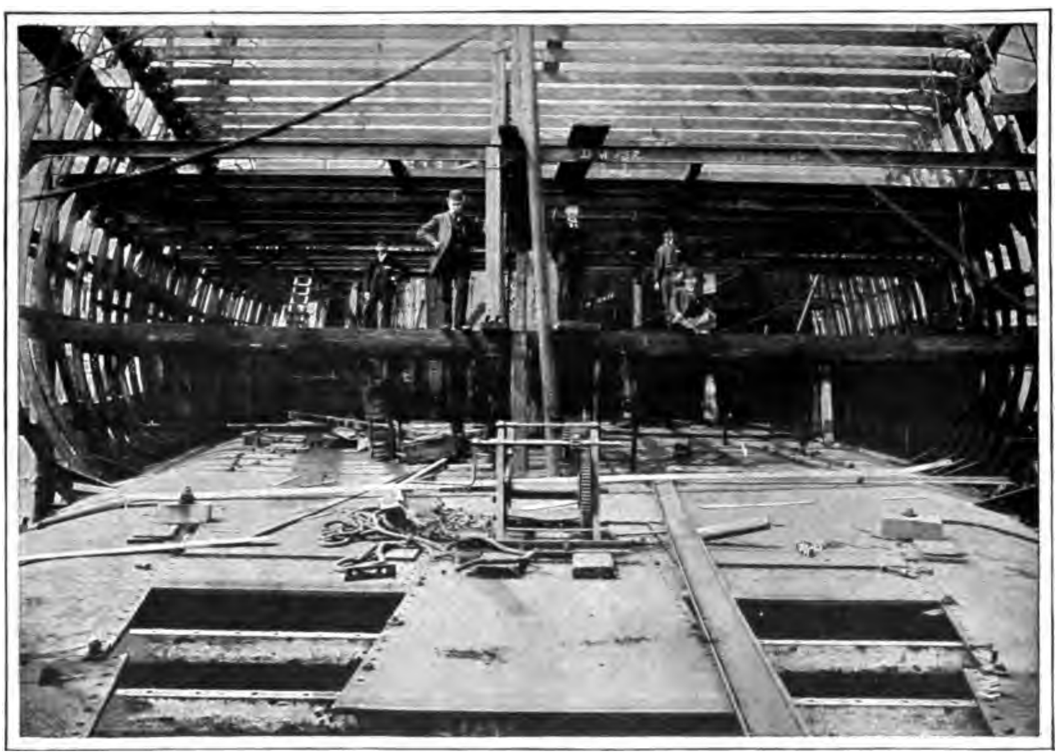


Photo supplied by Sir W. G. Armstrong, Whitworth & Co., Ltd.

VIEW FROM THE BOW OF A BATTLESHIP DURING CONSTRUCTION.

Photo: By permission of the Thames Ironworks and Shipbuilding Co., Ltd.

BIRD'S-EYE VIEW OF THE THAMES IRONWORKS SHIPBUILDING YARD, SHOWING TWO WARSHIPS UNDER CONSTRUCTION.

capable of doing so. At Barrow is a large yard owned by the Vickers company, and building the finest battleships and cruisers. Finally, at Birkenhead is the historic establishment of Laird Brothers.

The first step in the building of a battleship is the preparation of the design. This is accomplished at the Admiralty, by the Director of Naval Construction's Department. The Director works in concert with the engineering and gunnery experts of the Navy, and the general outlines of the design are laid down by the naval officers of the Admiralty Board. These officers, who may have to fight the ship, determine what the guns carried are to be, what the thickness of the armour, what the speed, what the coal allowance. The length of the ship and her draught of water are largely influenced by the size of existing docks.

Before finally settling the design, very careful tests are made to ascertain the best "lines" or form of ship to give a high speed. These tests are rendered possible by the construction of models which are tried in a large tank. By their aid the speed of the ship built, with a given engine-power, can be very accurately determined beforehand, and such unpleasant surprises are guarded against as occur when a ship designed to steam twenty knots is found to be capable only of making nineteen.

As soon as the general outline of the design has been settled, and passed by the Admiralty Board, detailed drawings and specifications are prepared. The most important of these are the "lines" of the ship, and to obtain them foreign emissaries are known upon occasions to have offered very large sums. The "lines" are a series of plans showing the variations in the section of the ship at various points in her length, the variations in the ground plan of her different decks, and the longitudinal elevation, indicating such matters as her "sheer" forward, or the cutting away of what is known as the "deadwood" of the keel aft, a feature in ships which are to be able to turn quickly and in a small circle. If the ships are to be built by contract, these drawings, with detailed specifications, indicating exactly the material to be used, the thickness of the plates to be employed, the type of engines and boilers, and a vast

number of other matters, are forwarded to certain selected firms who are known to be capable of executing the work in a trustworthy manner; they in turn specify the price at which they are willing to undertake it, and if their prices are satisfactory orders follow. A time limit is laid down within which the ship must be delivered. This is usually thirty or forty-two months, though it will depend much upon the emergency and upon the willingness of the Treasury to spend money on the Navy. The best record yet accomplished for the actual completion of a battleship from the date of "laying down" was accomplished by Portsmouth and Chatham in the case of the *Magnificent* and the *Majestic*, both of which were ready for sea in two years.

When the order to build has been given a great deal of preliminary work has to be accomplished before the ship actually appears on the stocks. Material must be ordered; perhaps such immense forgings as those required for the ram have to be obtained outside the yard which is building the ship. The engines are not, as a rule, made in our Dockyards, and must be ordered elsewhere, with certain limits of weight which are rarely exceeded. Everything used in the building of the ship, if it is constructed in a private yard, has to undergo rigorous inspection by officers whom the Admiralty deputes to guard its interests. Angle bars, steel plates, and the raw material generally are obtained from the great iron and steel works of the country, or, it may be, imported from America. Contracts are made for the minor engines of all kinds with which the battleship is crammed, for pumping engines, dynamos, capstans, hoisting engines, and so forth. The guns are also ordered by the Admiralty when the ship is laid down, as the construction of the larger pieces will often require two years, or almost as long as the building of the ship. The armour is ordered from the makers of that commodity.

Photo: S. Cribb, Southsea.

READY TO BE LAUNCHED.

Meantime, while these various orders are being placed, the ship's lines are being "laid off" from the drawings on a gigantic plank floor, known as the mould loft. It is so large that the measurements can be marked on it full size for breadth and depth, though for convenience the length measurements are generally contracted. In this process of enlargement from the small scale drawings errors will be detected and corrected. From the lines thus depicted particulars are transferred to what is known as the "scrive board." On this scrive board, which is also made of planking, the exact curves of the frames and beams, indeed of all the important structural

Photo: S. Cribb, Southsea.

STERN SHOWING BARBETTE. PUTTING ON THE ARMOUR.

details of the ship, are marked one by one, full size. When that has been done, the curve is copied from the scrive board on the "bending slabs," which are plates of iron full of small holes in which steel pegs can be placed, thus, as it were, dotting in outline the curve to which the frame is to be bent. The straight length of frame or angle bar is then ready for handling. Holes are punched where they are required, this being done by measurement from the delineation on the scrive board; the frame is next heated, bevelled by machinery, and brought hot to the pins which mark out the curve to which it is to be bent, and, in much less time than it takes us to write this, bent to the required shape. When bent and ready to take its place in the structure of the ship it is placed in position and rivetted.

The first process when actually building up the structure of the battleship is to lay the keel plates, which are prepared to drawings and to the outline on the scrive board, exactly as are the frames. The keel plates are upon solid masses of wood, slightly inclined from bow to stern if the ship is not being built in dock, and if she will have to be launched. Building in dock is quicker, cheaper, and less troublesome, because it obviates all the anxieties which attend the launch of a large vessel, but it has the serious defect of rendering it impossible to use the dock for any other purpose. To the keel plates the frames, which are the most important factors in the ship's structure, are bolted with rivets, and in the newest and most up-to-date establishments the rivetting, of which there is so much, is accomplished with great speed by the use of a hydraulic or pneumatic rivetter. The frames occur at short intervals from stem to stern, and to them the outer shell of plating which completes the structure is secured. They are held in place in the initial stages by strong shores of timber and "ribband-pieces." The deck-beams and longitudinal framing are then added; the floor-plates laid; and the mass of metal on the stocks begins to look like a ship. All the operations of cutting plates to size, bending and punching, are performed by machinery, which is of the simplest and most effective description. With the modern appliances it is a matter of perfect ease to shear 1½-inch steel plate, even to punch manholes at one operation. Machinery is more and more used for the transference

from point to point and handling of the heavy weights which have to be moved. Electric, hydraulic, and steam cranes are employed largely.

One of the chief features in the battleship is the armour deck, which divides the ship horizontally into two halves about the level of the water line. This is usually composed of several layers of the finest and toughest nickel steel plate. It strengthens the whole structure and holds it together. Before it can be laid in its entirety it is necessary to place the boilers and engines on board. This is done after the ship's launch, when she is brought under the "sheers," which are huge cranes capable of handling immense weights with ease—in some cases as much as two hundred tons. The armour on the outside of the ship is also almost always applied after the launch.

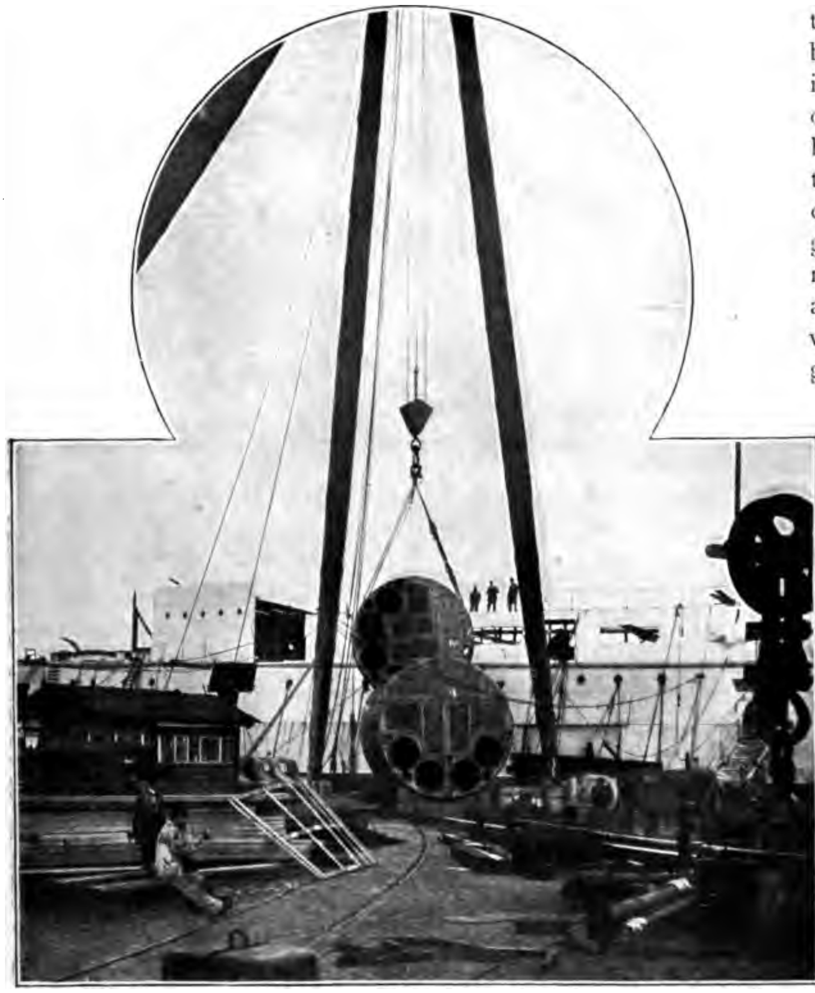


Photo: Gregory & Co., Strand, W.C.

HOISTING BOILERS INTO A MAN-OF-WAR.

The launch of a big ship is a very serious affair. In England battleships generally have about 6,000 or 7,000 tons of material built into them before they are placed in the water. In France, however, launches take place when the hull weighs only 3,500 tons, or even less. "Launching ways" of heavy timber are laid down, running parallel to the ship's keel; and on these, under the vessel, is built up a "cradle," which is so arranged as to slide on these ways. Then the bearing surfaces of the timber ways and of the cradle are greased with great quantities of tallow, much of which is recovered after the launch. The weight of the ship is gradually transferred to the cradle, but to prevent the vessel moving before all is ready a locking arrangement known as a "dog-shore" is employed, which must be knocked away before the ship is free to move. The "dog-shore" is now generally knocked away by mechanism, operated by the touching of a button or the cutting of a string, and arrangements are usually made to start the ship by a push from a hydraulic ram, so as to prevent the sticking on the launching ways, which used to be common in the earlier days. But with all care and precautions accidents occur, and sometimes very serious accidents. The most noteworthy of recent years was that attending the launch of the *Albion* at the Thames Ironworks in 1898, when the tremendous surge of water caused by the plunge of the ship into Bow Creek submerged a staging, drowning thirty spectators.

In spite of all precautions a ship will

generally alter her shape slightly in the process of launching, owing to the strains which she has to undergo. This accounts for the very curious fact that two ships built from identical designs never give the same result in the matter of speed. The most striking instance of this phenomenon is to be found in the case of the cruisers *Blake* and *Blenheim*, the former of which has always been a dismally slow ship, while her sister the *Blenheim* has a fine record for good steaming.

After the launch the inner works are completed; the armour placed in position, the engines and boilers erected; the decks closed up where gaps have been left for the passage of the boilers, and the vessel is then ready to receive her armament. The big barbettes fore and aft each receive their two huge 12-inch guns; in the casemates, which are structures of armour built into the hull of the ship, with on the outside 6-inch plate and on the inside 2-inch armour, the 6-inch quick-firing guns are installed; and the battleship is ready to begin her trials. The first trial is the turning of the engines in the basin, to ascertain whether all the parts fit properly and work. Then follow the steam trials at sea at various speeds, which usually reveal small defects, perhaps requiring some trouble to correct. The bearings in the engines often heat and need fresh adjustment. After the steam trials come exhaustive gunnery trials, in which all the mechanism for handling the guns is tested, and many rounds are fired from each gun. This final trial safely accomplished, the last touches are put to the ship, and she passes into the reserve, or goes directly into commission, hoisting the British flag, and joining one of the main squadrons which guard the British Empire. From first to last her cost will, if she is of the newest type, the King Edward class, displacing 16,500 tons, have been from £1,250,000 upwards, and the time occupied in her completion about three years.

H. W. WILSON.

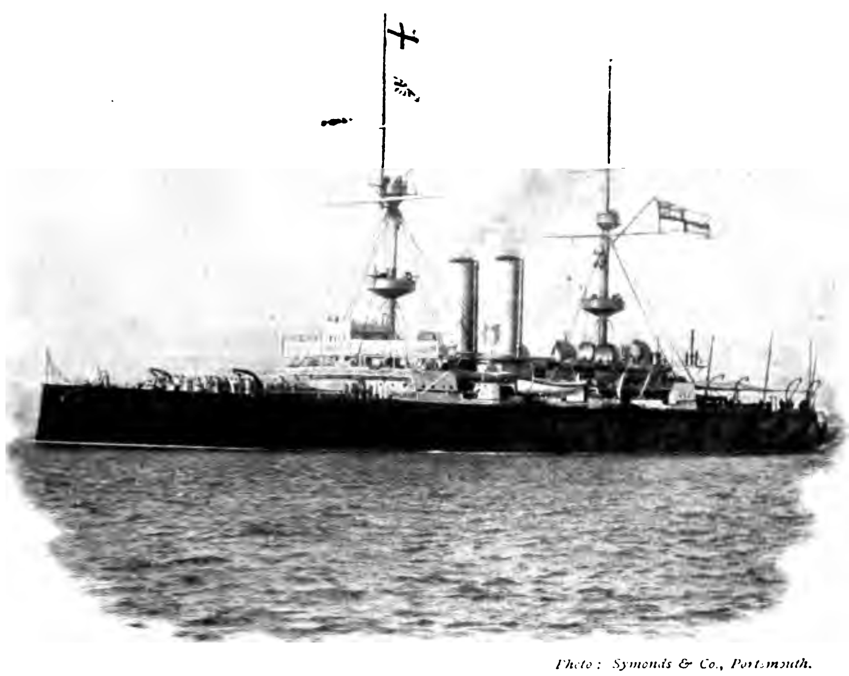


Photo: Symonds & Co., Portsmouth.

READY FOR ORDERS.

Photo: Cassell & Co., Ltd.

PLOUGHING WITH OXEN IN SUSSEX.

PREPARING THE LAND.

THERE is a widening gulf of separation between the interests of Town and Country. The busy hives of workers in South Lancashire and Yorkshire, in the "black" districts of the Midlands, and the gigantic population of Greater London, are to a great extent out of sympathy with the sparsely populated rural districts. And yet in the earlier memories of thousands of artisans and labourers in the towns there must lurk reminiscences of the country and of rural pursuits. The perpetual drain of country-bred youths into the manufacturing centres must tend to preserve such associations alive, but, as the years roll on, the impressions become fainter, and rival interests become stronger. The lines of separation between Town and Country do not stop at the working classes, but extend upward through the various social layers, and find expression in comparative indifference for the yokels and clodhoppers who "sow the seed and reap the harvest with enduring toil."

To many, the agricultural labourer is an object of something akin to pity. Until recently he had no political power, and even to-day he boasts of no union or trade organisation. His wages are low in comparison with the earnings of artisans, or even labourers, in towns, and the 11s. or 12s. a week which still represents the ordinary winter wage of a farm labourer in many districts is looked upon as scarcely sufficient to hold body and soul together. This does not, of course, represent total earnings, as these men take task-work or piece-work during the summer, and also have harvest wages.

The ordinary farm labourer is like his counterpart in every other occupation. He requires as much skill, but is, after all, only a labourer, and takes his instructions from a superior man. If we are to obtain a view of the class who till our fields and attend to our livestock, we must consider the regular staff employed upon a large farm over and above what are classed as mere farm hands or labourers.

The permanent staff upon such a farm would include the following leading men: Bailiff or foreman, shepherds, dairymen or stock men, head carters or ploughmen, labourers, boys.

As to the first three classes—foremen, shepherds, and stock men—it is not necessary to enlarge upon their capabilities or duties. They are not engaged in the actual work of preparing the ground for crops, such work being performed by the carters, under the eye of the master or bailiff.

In Scotland and the North of England each pair of horses is looked after and worked by a "hind" or ploughman. In Southern counties it is more usual to engage a head carter for each stable of six or eight horses, and to give him a considerable share of responsibility

"WHOA, STEADY!"

(From the Painting by Wright Baxter, by permission of Messrs. E. S. & A. Robinson, Colour Printers, Bristol.)

On large farms, where there are more than one homestead, there may be two, or even three, of these carters, with men and lads under them according to the number of horses. If eight horses are kept the equipment will consist of head carter, under carter, and two ploughboys, who will man four ploughs. The head carter must be a man of experience, who has gone through all the lower stages and entered a stable as a junior. He has probably served twelve to fifteen years as boy and under carter before he is considered to be capable of taking charge of a stable. His attainments are considerable, and his suggestions should be worth attention. The success of the farm depends a good deal upon the head carter, for he must be active and pushing, an early riser, and good manager. To give a man charge of a stable who has not served his time from early boyhood to at least the age of twenty-five would be a mistake. Not only must the carter understand how to feed and manage horses, but he must possess a good knowledge of farm machinery, such as self-binders, reapers, drills, and cultivators. He must also be well versed in tillages, and know the requirements of land.

HARROWING AND SOWING.

Photo: C. Reid, Wishaw.

The carter must be in the stable by five o'clock (in some counties earlier) to feed his horses, for this work is peculiarly his own. At six o'clock he goes to breakfast, leaving his helpers to groom and harness the teams and clean the stable. At seven o'clock the horses should be on the road to the field. The ploughman's day is in most cases from seven a.m. to four p.m., with half an hour for refreshments at twelve o'clock, but, as above stated, conditions vary in different districts. Thus the horses are nine hours out of stable, and about eight hours actually at work.

Photo: C. Reid, Wishaw.

PLOUGHING.

When the teams return, there is unharnessing, watering, grooming, and littering up, which will occupy at least an hour. The helpers then leave the stable, but the head carter will return about eight o'clock to feed his horses and fill their racks for the night. The carter has, therefore, a long and arduous task, and a responsible position.

The wages paid to such a man are generally made up by privileges and perquisites of old standing, and may be indicated somewhat as follows: Weekly wage 14s., equal to £36 8s. per annum; harvest—overtime, etc.—money at Michaelmas, £5; house and good garden, £4; 1s. every journey with corn, etc., say 20, £1; fuel carted, say, 10s.: in all, £46 18s. His wage averages 18s. a week, which is equivalent to at least 25s. in a town.

The work of a farm is continuous throughout the year, and reflects the seasons as they pass. It is fascinating, poetical, scriptural, classical, and idyllic. It has been less influenced and modified by modern inventions than any other industry; and remains as an illustration of cultivated and regulated NATURE. Agriculture is neither an art nor a science, nor is it a trade. It is an occupation and a craft. Its maxims are a lore, rather than set rules, and must always be altered according to circumstances.

Britain may be viewed as one farm extending from county to county, interrupted by towns it is true, but surrounding them like the ocean surrounds an archipelago of islands. If we view our farming in this way we may grasp its wide extent and endless variety.

Great Britain possesses a total area of 32,437,389 acres of cultivated land, of which 7,325,408 acres are under corn, the rest being in permanent pasture, temporary pasture, root crops, fodder crops, etc. It includes over 51,000 acres of hops, 73,000 acres of fruit, and 308,000 acres of bare fallow. The capital employed is enormous, and may be roughly estimated at £227,000,000, while the amount paid in wages has been estimated at £30,000,000 per annum. There are at least 1,000,000 men, women, and boys employed in agricultural pursuits in Great Britain who not only cultivate the ground, but attend to 1,500,000 horses, 6,805,000 cattle, 26,500,000 sheep, and 2,381,000 pigs, besides countless poultry. Such is John Bull's farm. Let us glance at the various operations which this enormous area necessitates.

Photo: Cassell & Co., Ltd.

MANURING THE LAND ON AN ESSEX FARM.

I purposely laid stress on the ploughmen, because the plough is the principal instrument for preparing land. Harrows, rollers, cultivators, and drills are all employed, but the principal act of cultivation is the breaking up of the land, either by horse or steam ploughs, and steam cultivators.

The plough, like the spade, turns over the soil and exposes it to the winter's frost, to the air, and to changes of temperature. The implement has been improved, but retains its more primitive form and function. The single-furrow plough is mostly employed, and one man and two horses will turn over one acre in one day, although the average

daily performance is fractionally less. By cross ploughing the land is further pulverised, and the final tilth is secured by harrowing and rolling. In corn growing, the work is comparatively simple, and often consists in one ploughing, repeated harrowings or "dressings," as they are called, drilling in the seed, and harrowing or raking it in.

Steam ploughing and steam "cultivating," or scarifying, are also used, but this innovation has not infringed much as yet upon horse ploughing. It is chiefly employed on the stiffer sorts of soils, and also as a means of overtaking arrears of work in critical seasons. It is generally done by contractors, who send their tackle to farms, and receive a price per acre.

Whether ploughing is done by oxen, horses, or steam, or whether it is done by an improved plough or one of less modern form, is not so important as that the ground should be thoroughly moved, regularly inverted, and in a word, soundly ploughed. Hence a skilful farmer who has a fancy for working bullocks in teams may obtain as good a result as one who employs horses, or as one who uses steam. Successful ploughing depends upon its thoroughness, its being well timed and judiciously carried out in respect of weather and season. The great point is to secure a good tilth—that is, a sufficiently deep, moist, and well pulverised seed bed—irrespective of the power or the precise form of the implement used.

Photo: C. Reid, Wishaw.

ROLLING, SOWING, AND HARROWING.

Corn growing is simpler than what is known as "root" cultivation, because the latter work involves the clearing of the land from weeds, and the application of the necessary manure. Roots include turnip and mangel cultivation, and their production is always expensive, and depends more upon the amount of moisture in summer than do the corn crops. It is more risky, and of late years has been disappointing, owing to the prevalence of drought in summer.

The work of sowing is done all through the year. In January, February, March, and April beans and peas, barley and oats, and grass seeds are sown. In April, May, June, and July the root and fallow fodder crops are drilled, such as mangels, potatoes, turnips, swedes, rape, and kale. In August, September, and October winter fodder crops are sown, such as trifolium, winter rye, winter barley, winter oats, vetches, etc. In October, November, and December wheat is generally sown. The drill or the broadcast machines are therefo.e always at work.

The old system of broadcasting by hand from the traditional seed-lip or seed-hopper is seldom now used, and the drill, which

Photo: C. Reid, Wishaw.

SOWING WITH THE DRILL.

deposits the seed at a regular depth in rows of fixed width apart, is preferred. It may, however, be remarked, as indicating the primitive nature of agriculture, that there is no evidence that better corn crops are obtained after drilling than after broadcasting. It is a matter of convenience rather than of superiority in ultimate results.

The rotation or regular succession of crops has much to do with what may be called preparation of the land. The direct ploughing and harrowing constitute the immediate cultivation, but the root crop prepares the land for corn, in consequence of the manuring and cleaning its cultivation necessitates; and the clover crop is an excellent preparation for wheat. Folding sheep on the land is done as much for the benefit of the succeeding crop as for that of the animals themselves, and the hay, straw, and turnips (roots) raised and consumed by the live stock produce the manure which is necessary to keep up the fertility of the soil. Space does not allow of a detailed account of the many "artificial" manures and purchased foods which supplant the manure produced on the holding, but the plough and the manure cart still remain the most important agents for preparing the land for the final result—meat, milk, wool, and corn.

JOHN WRIGHTSON.

Photo: C. Reid, Wishaw.

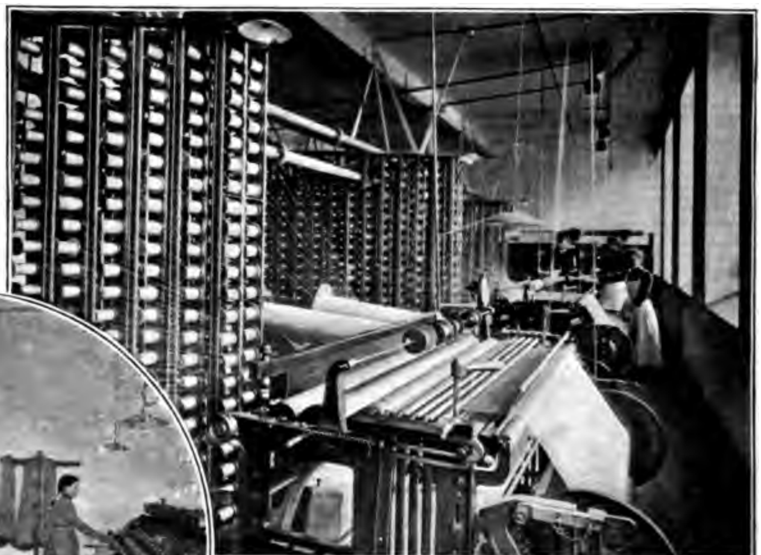
BURNING WEEDS.

IRELAND'S CHIEF INDUSTRY.

THE MANUFACTURE OF LINEN.

IF there is one industry which more than any other is characteristic of Ireland, surely it is the making of linen. There is no special reason why the fabric should be made in that portion of the British Empire termed "the distressful island," still the fact remains that Irish linen is celebrated the world over. Were we to attempt to trace in detail the history of linen we might wade back page after page and century after century. The bygone past, however, need not delay us now beyond the fact that the real foundation of the flourishing linen and cambric manufactures in Ireland was laid, perhaps, in a law passed by Parliament during the reign of William III., allowing flax, linen, and linen yarns produced in Ireland to be imported into England by natives of both countries.

In the earlier part of the nineteenth century the click-clack of the hand looms made familiar music in thousands of homes all over Ireland. In fact, one of the most prominent buildings after the chapel in the majority of the towns was the Linen Hall, which was the market where the peasants displayed their web to the critical gaze of the exporters' buyers. The introduction of steam power for spinning, however, proved the death-blow to the cottage industry in the south and west,



BEAMING THE WARP YARN.

WINDING THE WARP YARN.

and to-day it is quite unusual to see a web of linen exhibited in a market outside Ulster.

It is only in a small portion of Ulster that linen is made. That is, perhaps, one of the most remarkable facts associated with the manufacture—the exceedingly small area within which it is circumscribed. It is doubtful if there is a trade of such magnitude and such importance confined within so small a space. What the importance of this spot, which on the map of Ireland in an ordinary school atlas may be almost hidden by a penny piece, is, may be understood by the following facts:—In one year (1893) alone, the yarn spun by the countless mills in this district was estimated to measure about 644,000,000 miles. To grasp

what this means is to realise a gigantic ball of yarn, which, unwound to its single thread, would encircle the world 25,000 threads. In a three-ply cord the same yarn would reach from the earth to the sun and back again; or, should we desire to pay a visit to the man in the moon, our big ball of yarn would give us a network road having 380 threads extending the full length between our planet and his.

And what of the cloth which a year's output of yarn might be woven into? It represents a web containing about 156,000,000 yards. We might unroll this Gargantuan web and make a path three feet wide, and on its snowy whiteness, laid flat, we would be able to make a triumphal tour completely around old Mother Earth at the equator. We might make a tent of the big web manufactured in the Belfast Linen district, and what a wonderful tent it would be!—such as would amaze even Haroun al Raschid. With the dome of St. Paul's for its centre support, this glorious linen canopy would cover 500 acres and stretch as far out over London as twelve-and-a-half miles on all sides. To spin the yarn necessary for this gigantic white expanse of linen 838,582 spindles were working, while its further conversion, by weaving, into fabric necessitated 32,245 looms. In connection with its varied processes nearly 70,000 people find occupation in the Belfast district.

Nor must one forget the gigantic financial equivalent represented by this space which a penny piece covers on the map, for in the numerous mills and warehouses in Belfast district no less than £13,000,000 sterling are invested. And not without return either, since the total value of yarn—piece linen and other varieties of linen goods—produced is estimated roughly to amount to over £8,000,000 sterling during an average year.

So far we have dealt merely with the important place the industry occupies in industrial economy. But we have not come any closer to solving the mystery of the production of the linen which has made Belfast a household word in the African jungle depths as in the frost-beleaguered Klondyke; in the Far-East joss-house as in the polished Court of St. James's.

To explain the various processes by which a handkerchief, or for that matter a damask tablecloth, is produced, we must begin in the manner the crab progresses, by moving backwards. In this way we shall find ourselves, in imagination, in the

TOWEL AND DIAPER WEAVING.

CUTTING SHIRTS AND COLLARS.

centre of a field of growing flax. It is brilliant July weather, and the noonday sun beams down on a scene of transcendent beauty; for if you have never seen an Ulster flax field in blossom you have missed one of Nature's prettiest panoramas. Around us the modest flax plant, with its exquisite green stems crowned with daintily small bright blue flowers, reaches knee height. Three weeks hence the blossoms will have given place to the seed pods—the linseed of commerce—but it is the sinewy stems we have to do with. Some fine morning will come a band of happy harvesters, lads and lassies, who will proceed in an extended line, pulling up the stems with their naked hands right and left as they go. The flax is then made up into small sheaves or bundles, tied loosely to permit the air to freely pass through them, and afterwards set up in stooks with the roots downwards for three or four days (according to the weather) to ripen and firm. Bound with rushes, these little sheaves are next taken to a convenient watering pool—known to the initiated as the flax-hole—where it is submerged under the weight of large stones. This process, in the Ulster dialect known as "retting," consists in a putrefactive fermentation lasting about a fortnight, by which the woody straw of the stem softens and disunites from the firmer stringy fibre.

And now, sufficiently retted, the wet flax is carefully taken from its bath and thinly spread over grass lawns to undergo a few days' exposure to the air, which helps to complete the step begun in the fermentation process. The firm dry stems are now gathered up, the fibres being carefully ranged lengthwise, and transported to the scutch mill. It is not a very intricate operation, this scutching, consisting as it does in the flax being first bruised, so that, when afterwards exposed to the blades of a revolving shaft, the rough fluffy portion is peeled away as tow, leaving the long fibres, which are here for the first time flax in the strictest sense of the word.

In the spinning mill the flax, freed from its foreign substances, is "heckled." In other words, it undergoes a remarkable toilet operation, since its hair is combed by a multitude of mechanical barbers till not one fibre is awry. In earlier days hand combs sufficed. Now the combs are a set of rollers covered with teeth of fine steel wire. Six or seven

AN ULSTER BLEACH GREEN.

STITCHING GENTLEMEN'S SHIRTS.

THE WASHING DEPARTMENT.

IRONING DEPARTMENT.

millions of these teeth garnish a single machine, and the rough, unkempt fibres which pass in at one end may be traced through their progress between these scarifiers, and then through between fluted rollers until they emerge first into a narrow, and afterwards in a broad, glossy, even lop of softish fibre.

This sheet or sliver is gathered up, forced through narrow apertures in a roving frame which draws it out and twists the fibres together by means of a flyer and spindle into what is called a rove, at the same time winding it upon wooden bobbins. These bobbins are then placed on pins on the spinning frame, and in this process the flax is passed through the rollers of one drawing machine after another, grows longer and longer, and the fibres lie more and more closely together. Then a final passage through boiling water is given, when the fibres are tightly twisted into perfect yarn or thread. This yarn is now reeled into hanks, dried, so that it may recover its natural elasticity of temper after its ordeal, as it were, and made into bundles of 60,000 yards ready to be taken to the market and to the weavers.

The spinning room in a large mill is not a place for nervous or irritable people. The great frames clack, clatter, and whirr as they move to and fro, spindles go whirring round so swiftly as to blur their outline, and the noise is very great. The temperature is high, the moisture considerable, and husky fragments of rough flax float about. Yet it is not an unhealthy class of work, and the workers look robust and strong enough. The humidity of the atmosphere is an important factor in spinning. In order to spin very fine linen yarn the threads of flax must be kept moist. Continental manufacturers have tried to manage this problem by providing artificial moisture in the factories, but here Dame Nature steps in to compensate the "distressful land," for nothing quite equals the natural dampness of the Irish air.

But to revert again to our handkerchief: we have only reached the half-way—the yarn—stage in its story. Examine a handkerchief closely, and you will observe how it is made up of countless fine threads crossing one another, and always at right angles. Originally these threads were of the raw greyish colour of the yarn, as we have seen it leave the spinning mill in hanks. How the threads of yarn were woven together into cloth is our next step of interest.

To see the weaving process properly one must go to the home of the handkerchief and linens of all classes, so the photographs illustrating this article, of machinery in actual work in the great power-loom factories of Messrs. Robinson and Cleaver, will give a better idea of the various stages than chapters of words. It must not be supposed, however, that power-loom weaving has entirely superseded the hand loom. Even in this day of almost perfected machinery the finest linen weaving is done on hand looms in the cottage homes of the weavers.

There are many technicalities connected with the power loom with which the reader need not be troubled. As the principle, however, in these intricate machines is virtually the same as that of the hand loom, it would be well to explain the meaning of the words warp and weft. The warp carries those threads which run the whole length of the cloth, while the shuttle flying across leads the threads comprising the weft under and over them alternately. At each passage of the shuttle the "reed," between the wires of which each thread of the warp is passed, moves up and presses the last thread of the weft close up to those which have preceded it, and so a compact piece of cloth is gradually formed at each beat of the loom. In this way plain linen stuff is woven. When it comes to fancy linens, towels, damasks, etc., a more complicated process is resorted to. It was the discovery, a century ago, of a method of working in patterns which made the name of Jacquard, the French silk weaver, known throughout the world, and brought about a revolution in producing fabrics. The Jacquard machine, which is used both in hand and power looms, consists, briefly, of serried rows of needles with their points projecting from a frame behind a perforated metal box turned each time the warp threads are raised to allow the shuttle to pass. The needles are so ingeniously arranged, however, that they cannot enter into all the holes and so lift all the warp at once, there being a number of cards perforated in such a manner as to form the design by lifting only certain threads at a time.

Though the vast bulk of the linen-weaving industry is now carried on by the steam-driven factories, still the finest class of work, such as serviettes, tablecloths, d'oyleys, etc., of the purest linen yarn gives employment to thousands of workers in their homes. It is well suited, since all the members of the family can lend a helping hand, the children and the aged winding the unbleached yarn on the bobbins for the weft, the young men and women weaving the narrower and lighter looms, and the able-bodied men the wider, heavier, and more complicated ones. There is a hankering after independence in the sturdy Ulster nature, and nothing pleases the average man like being able to do his own work for his own advantage.

But we are in danger of wandering from the story of our handkerchief. Fresh from the weaver's cottage or the power loom of the factory comes a web of rough, coarse, strong, brownish fabric. It seems impossible that this dirty-looking cloth will become transformed into my lady's dainty handkerchief; but that is so, as we shall see.

Straight from the loom, this web of brown

HAND-LOOM WEAVING HEAVY LINEN SHEETING 150 INCHES WIDE.

linen goes to the bleacher. Until this very day the old-fashioned methods of bleaching are usually employed, and Nature, in the shape of her moist climate, defying Art in the person of the chemist, more than maintains its pre-eminence for producing that dazzling pure whiteness which can only be found in Irish linen, bleached on the lovely green fields of the Emerald Isle. To see the long strips of linen spread out on Ulster grass fields is a sight which will not be readily forgotten.

From the bleach green the roll is transported to the factory, which is situated in Belfast itself or one of the surrounding towns. In our case we follow the spotless bale to Belfast, and in the cutting room

we shall now see how the handkerchief begins its existence as a separate entity by being cut from the web. The same process is gone through in the case of a collar, a pair of cuffs, a shirt, or any other article of garment. From the cutting department its next ordeal is to pass into the hands of the hemstitchers. If the handkerchief is a plain one without any ornamentation, we have now almost reached the end of its history.

Let us suppose, however, that it is one of the elegant embroidered mouchoirs so highly esteemed by the ladies of high society; then back again it goes from the city factory to revisit once more the scenes of rural bliss. Week by week to the factory come hundreds of women—youthful, middle-aged, and old—to fetch handkerchiefs, tea-cloths, etc., which require to be embroidered or have lace inserted, shirts, collars, and cuffs to be buttonholed. Next week they will return them with the necessary buttonholing or embroidering completed, when the farmer's cart—their own or that of a kindly neighbour—is coming to Belfast market. So our handkerchief has now returned to the factory, beautifully embroidered by its country jaunt.

The handkerchief looks a little bit limp and crushed after its embroidering operation. But the fatigue is only temporary. Up in the washing department a white-aproned maid receives it carefully. So into the bath it goes, and no bath attendant could be more scrupulously careful in looking after her charge.

Out of the bath into the drying closet it progresses; and then, to assume the stiffness of pride befitting the dignity of an embroidered handkerchief of the distinguished Belfast house, enters the ironing department. Surely never handkerchief ever underwent such toilette as this. But the end is almost in view.

Away high up, near the roof, tasteful hands have prepared a dainty morocco travelling casket which will just accommodate our handkerchief and five companions, as like each other as can be. A blue ribbon gives the finishing touch, and to-morrow the soul of the pretty blue-flowered flax plant we saw growing in an Ulster field is on its way to far Japan or down-under Melbourne.

We might have traced the history of a collar, a serviette, or a tablecloth, for that matter. Their development is akin to that of the handkerchief. This is the work which goes on every day in the vicinity of Belfast that the world may have its linen cloth; and though other countries try hard to rob Ireland of the honour of being the chief linen centre of the earth, not one of its competitors can turn out linen so well, so cheaply, and so beautiful.

ALFRED S. MOORE.

Photo: R. Welch, Belfast.

IRISH PEASANT WOMAN AT WORK EMBROIDERING LINEN.

BRITAIN'S UNDERGROUND WEALTH.

HOW COAL IS BROUGHT FROM THE PIT TO WORKSHOP AND FIRESIDE.

Photo: Arthur Sopwith, Esq., C.E.

A MOMENT'S CHAT BY THE WAY.

COAL has wrought much evil, polluting the atmosphere of our great cities; yet the gleam of fire-light on the hearth, the amber and sapphire flame of the furnace, and the red glow of the engine fire on liner and on the railway track, tell of home comfort, trade enterprise, and quick travel.

There are three extensive coalfields in the kingdom: the northern, embracing the beds of Fife, Stirling, Ayr, Cumberland, Newcastle, and Durham; the midland, comprising the great coalfields of Yorkshire, Derbyshire, and Staffordshire, as well as Shropshire, Flint, and Denbigh; and the southern, which includes the rich steam coal deposits of South Wales, and the seams in the Forest of Dean, and at Bristol and Dover. Roughly, the seams, producing coal of infinite variety, vary in thickness from two hundred feet in Lanarkshire, which give more than half of the Scotch supply, to one hundred feet in Lancashire and forty-seven feet in Northumberland and Durham. The yearly output from these seams is enormous, bulking to 225,000,000 tons, of the value of nearly £125,000,000 sterling.

The most pessimistic experts admit that though the demand for household, manufacturing, export, and coal station purposes is still increasing, the available coal supply of the kingdom will not be entirely exhausted till three hundred years hence. Even then the population will have scarcely any cause for panic. They may have to tolerate the importation of foreign coal; but the chances are that long before the coal-beds of Great Britain give out, science will have wrested an altogether new fuel out of the elements. Meantime, coal production has developed into an enormous industry.

In the past half-century the output has increased fourfold, and the getting, filling, hauling, and moving of the coal from the pit banks means the employment of nearly 800,000 colliers and other hands who toil in or about the pits. Nor does this number of workers give any idea of the vast amount of work that the coal output makes possible. The pitman, ever tussling with the forces of Nature and with the capitalist, is almost

HEWER AT WORK. *Photo: Arthur Sopwith, Esq., C.E.*

unconsciously belligerent. Anyhow, he is self-reliant and resolute. He is the autocrat of industry. If, as occasionally happens, he comes out on strike there is not only a flutter among the coalowners, but consternation in workshop and factory, and on steamboat and railway, for he is "the prime factor in our industrial system," and the trade of the country is paralysed without him.

However early coal was found in England, Scotland, or Wales, the miner has always risen early to delve it, even when he laboured in crude workings with antiquated iron pick and wooden shovel. Now at dawn, with his "snap" (his food) in his jacket pocket, and his tea-can slung on his belt, he quits his humble cottage in the colliery village, and joins his mates on their long or short tramp to the pit bank. The bell rings. There is a shuffle of feet, and the cage, crowded with miners, descends the shaft, the return cage gliding, phantom-like, high above them.

At the pit bottom, shallow or deep, the men get their safety-lamps, and go on foot, or are conveyed in corves, drawn by ponies, or steel haulage, or electric cable, along the main road to the nearest point to their working places. If the mine is very gaseous they give a careful look to their lamps as they start along the narrow subterranean way to the coal face, note the warning on the heavy ventilation door or clinging brattice cloth: "There's fire in Simpson's gully." In one pit in South Yorkshire, to which the writer once penetrated in the guise of a collier, there is a curious fault. The coal-seam has been split by volcanic action. The lower part of it is workable on the level near the main road; but the upper part of it, lifted many yards high, has to be reached either through a subsidiary shaft, cut through the shale and sandstone, or by a rusty ladder flung over the face of the fault, hereabouts covered with lather coating or mud.

Photo: Arthur Sopwith, Esq., C.E.

PIT BOYS GUIDING TRUCKS.

There are many curious ways to the workings in various mines; but none too crooked or tortuous to outwit the miner, who is nothing if not dogged and undemonstrative, though he may have to trudge and crawl for an hour underground before he reaches his working place. Here, as seen in the illustration, he strips to the waist, tightens his belt, and begins his task of coal-hewing. His safety-lamp, possibly an improved Clanny, hangs from its hook on the nearest prop, and by its light he holes, picks beneath the face of the coal, till what the housewife familiarly speaks of as nuts, cobbles, and slack heap about him, and the filler loads the corve, which, impelled by its own weight when filled, clatters down the side track to the corve train on the main road for transit to the pit bottom. By-and-by, after the use of lever, or explosive, the mass of coal beneath which the collier has holed comes down with a crash, in mighty slabs, and the wedger, with his vast strength and heavy, long-handled hammer, reduces the huge pieces to handling size, for transit to the corve; and so the work of getting and filling goes on till "snap" time, unless toil is sharply checked by the cracking of prop, the move of roof, the deadly fall of bind, or the explosion that riots through the mine with fiery breath.

There are two chief methods of working the coal. In the north of England partiality

AT THE BOTTOM OF THE SHAFT.

PIT-BROW LASSIES CLEANING COAL.

(Photos by permission of the Wigan Coal and Iron Company, Ltd.)

Photo: By permission of the Wigan Coal and Iron Company, Ltd.

AT THE PIT MOUTH.

is given to pillar working, narrow ways being cut this way and that in the seam, leaving solid blocks of coal to be worked out. The long-wall system, in vogue in most other pits, consists of the making of tram roads to the face, and working out the coal along its whole length of the seam, or so much of it as has been roofed and propped to facilitate excavation. The "iron man"—the collier's name for the coal-cutting machine — is gradually coming into more extensive use in some pits. It is in the pit what the "Tearing Devil," or steam navvy, is in railway cutting. It works without comment about pay and hours of labour, and has been found useful wherever tried. In the Scotch pits the coal-cutting machine has become a valuable adjunct in production, and it will, as time elapses and the thick seams get worked out, prove of the greatest utility in cutting thin seams, not only in Great Britain but in many other parts of the world.

The collier is better paid than formerly for his day's toil, which lasts from six o'clock in the morning, with his interval for "snap," till about two o'clock in the afternoon. He also works under more improved and safer conditions than he did sixty years ago. Then the ventilation was bad and the tone of the mine depraved. It is singular to note to-day, when women are showing a disposition to quit the fireside to compete with men in various professions and trades, that in the 'forties the English and Scotch pits contained girl and women workers. They were in the main an ignorant set, and their toil debased them. The conditions of life in the pit were so barbarous that the attention of the Government was directed to the scandalous incidents of the mine.

Women were, immediately after the Government inquiry, prohibited from working in coal-pits; but they were permitted to continue their toil as "pit-brow lassies" in unloading, screening, and sorting the coal on the pit banks. They have, to use the language of the Legislature, become a "noble and fine class of women"; and there is no more striking picture in English industrial life than a Wigan pit-brow lass, clad in close-fitting pitman's cap, rough jacket, short skirt, well-patched moleskin trousers, and Lancashire clogs, twirling a laden corve.

The miner has, by organisation and labour leader, made himself heard not only in the conference of coal-owners but in Parliament, and he consequently works under superior conditions as to pay and environment. The ventilation is as perfect as known system of up-cast and down-cast shaft, and pumping, fanning, and the sprinkling of coal-dust can make it. The main road and the working place are maintained in better repair, and special attention is about to be given to timbering, with the object of preventing, as far as possible, the falls of bind that the miner dreads almost as much as the more disastrous but rarer explosion. There has been improvement in safety-lamp, in pit lighting by electricity, and in

haulage; but perhaps the greatest revolution with regard to the coal industry has been in the transit of the commodity itself.

The transit of coal from the pit bank to house and distant market is practically a separate business from the industry of coal-getting. The cost of carriage nearly doubles the price of coal to the consumer; and there has, since the coaching days, been innumerable attempts made to reduce the outlay in transit. George Stevenson's first engine, which heralded the development of the railway system, was constructed for the purpose of conveying coal from Killingworth pit. Cart and waggon, the latter now drawn by traction engine, are still seen coal-laden on highway; but, except for local delivery, the railway has become the great carrying agent of the coal-owner and the dealer. Now and again the demand for coal was so great that the railway was altogether unable to cope with it. The canal as a coal-carrier lapsed into disfavour with the impatient consumer, and fifty years ago there was a block of five miles of coal trains on the line between Rugby and London. The metropolis had overcome its prejudice against coal, and was clamouring at every terminus for fuel. Glasgow, Manchester, Leeds, Sheffield, and Birmingham are gigantic consumers; but London is absolutely ravenous, and draws her huge supply from the gigantic coal sidings that spread fan-like on the borders of the great city, and are fed by the three or four trunk lines that are in touch, by numerous rail-tracks, with the pits of Staffordshire, Derbyshire, Yorkshire, Lancashire, and other coal-producing districts.

Every railway, wherever possible, has cultivated the coal-carrying trade, because it is profitable, especially on long-distance runs. The Midland, with its main line striking through the heart of the Derbyshire coalfield, and with tentacles all around, has the premier coal traffic, and needs thirty thousand waggons to handle it. But the North-Western, the Great Northern, the North-Eastern, and the Great Eastern do not lose a chance, and lately the Great Central, weary of acting simply as the cross-country jackal to the other companies, has forced

Photo: Cassell & Co., Ltd.

COLLIER FLEET LOADING NEAR NEWCASTLE-ON-TYNE.

its way to London, handles the coal through from the pits on its system, and is striving to get a profit.

There is nothing particularly interesting in the transit and use of coal by rail except the marshalling of the waggons by gravitation, the language of the merchant or dealer if his trucks have not arrived in time to meet the demand, and the more indignant tirade of the railway shareholder against what he calls the Company's gross extravagance in accepting locomotive coal contracts at exorbitant prices. But in coal shipment for export there is much ingenuity apparent, for the docks are equipped not only with jetty lines, but hydraulic cranes, swinging cradles, hoists, shoots, and other appliances deftly contrived to load the smallest or the largest vessel. The shipment at Tyneside, at Hull, or at Cardiff, the latter the port of largest coal export, is a sight to see—that is, if you can see it, for there is a significant warning in the Welsh harbour: "Keep off the quays, as the coal-dust, especially in calm weather, makes the water look like land."

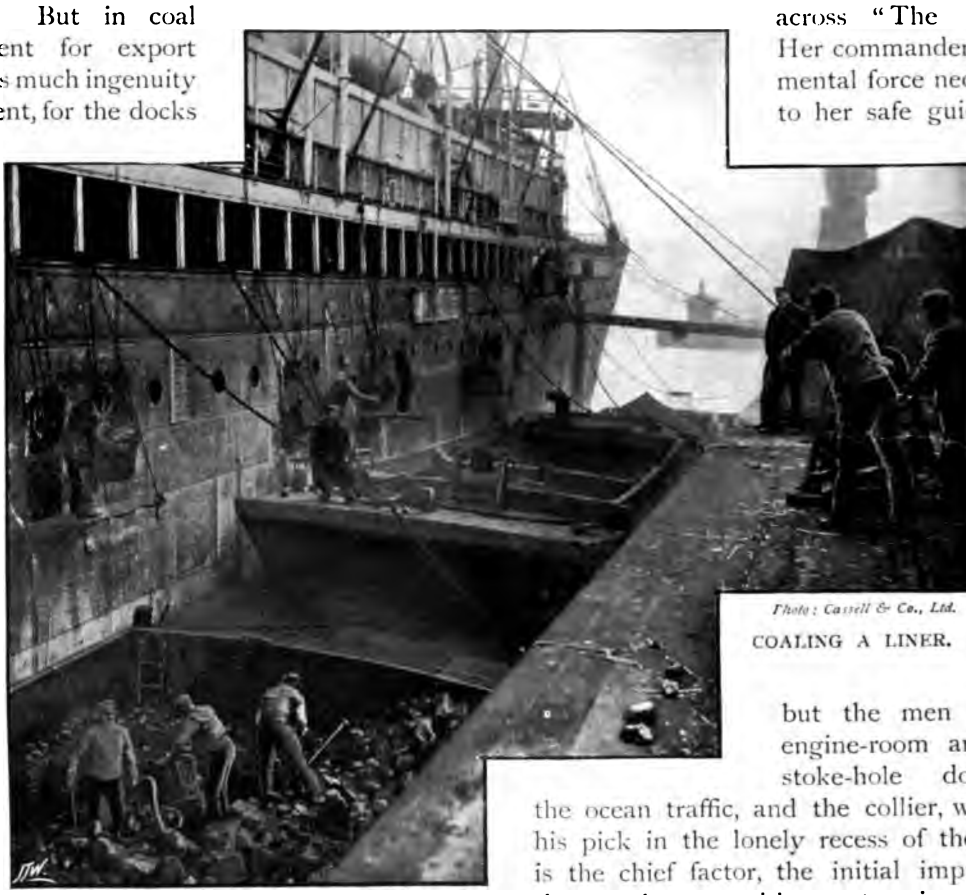


Photo: Cassell & Co., Ltd.

COALING A LINER.

Apart from the vast quantity of coal shipped for use abroad, the consumption of fuel on board our steamers is, as every traveller is aware, enormous. The engineers and stokers on a modern liner are the despots of a tropical kingdom. "The *Lucania*," says the Cunard agent, strolling along the Huskisson Dock at Liverpool; "well, I should not go aboard to-day—she's coaling!" There is no doubt about it. She is stripped of her finery for the purpose, and a myriad of men, with the latest appliances, are loading her capacious bunkers with fuel to drive her across "The Ferry." Her commander is the mental force necessary to her safe guidance; but the men in the engine-room and the stoke-hole dominate the ocean traffic, and the collier, wielding his pick in the lonely recess of the mine, is the chief factor, the initial impulse, of the wondrous maritime enterprise.

The *Oceanic* is berthed close by. There is a glittering film of coal-dust on her great black hull, and the shed that spans the dock-side is thronged with a procession of grimy men who have just completed the coaling of the leviathan. The floating palace, over seven hundred feet in length, has no fewer than ninety furnaces, and thirteen boilers, to drive the engines of twenty-eight thousand horse-power, and she consumes seven hundred tons of coal daily, when on the move, utilising nearly five thousand tons on each voyage

across the Atlantic. Charles Dickens would no doubt have found the English language altogether inadequate for his criticism of her funnels. There are only two of these drab-painted orifices; but they are as lofty as large ship-masts, so wide that two tramcars could run through them abreast, and when the great fires are banked up as hot as the stokers can make them, yet the ship is skilfully safeguarded against their fiery breath.

Carlyle said society is founded on cloth; rather is it established on coal. The world would be a cold and cheerless, and also a stagnant place, without its heat-giving, or other equivalent; and the only objectionable feature about the fuel is its high price. Not even the poorest householder begrudges the miner his wage, for he gets it with incessant toil and at imminent risk from outburst of gas, insidious after-damp, and inflow of water. He is a bread-winning hero, who never shouts about his valour, though his courage and daring in saving life cannot be surpassed. He does not rake in much profit, or do everything to keep the price high. Nor does the coal-owner always come "best side out" on the year's working, considering his outlay of capital and the fluctuation of the market.

The carrier, and the merchant or dealer, have often a better chance of aggrandisement. Even in Lancashire, in the midst of a rich coalfield, where the carrying charges should be light, house fire coal, of good quality, is not delivered at the back-yard door at less than a sovereign a ton, while the man with the barrow and the shovel makes his bargain with all the diplomacy of a big contractor, and demands eighteenpence or two shillings per cart-load as the price of placing it in the cellar. The coal agent and the coal heaver are doggedly of opinion that a good thing is worth paying for; and however hardly the London, Manchester, Liverpool, Sheffield, Birmingham, or other citizen may think he is treated by the coal trader, he has the melancholy satisfaction of knowing that in the seventeenth century the price of coal in England was much higher, Pepys stating, in his Diary, that such was the dearth of coal, and so great the despair of any supply owing to the vigilance of the enemy, that the fuel, when it could be got, realised the famine price of £5 per ton!

JOHN PENDLETON.

Photo: Cassell & Co., Ltd.

THE MANUFACTURE OF TOBACCO, CIGARS AND CIGARETTES.

THE cultivation of the tobacco plant finds no place in a list of the industries of the United Kingdom, not because it is forbidden by nature, but because it is suppressed by law. In the year in which Queen Elizabeth ascended the throne of England, one Jean Nicot, ambassador of France to the Court of Lisbon, learned of the arrival for the first time in Europe of the seeds of a plant which was destined henceforth to bear his name. He sent some of these seeds to Catherine dei Medici, and it was not long before the plant began to spring up in various parts of the Continent. In the middle of the seventeenth century tobacco was already being raised in England, but the new crop was forbidden by Charles II., who desired to encourage the produce of the Virginian plantations. The plant was grown fitfully for a century and more, but tobacco cultivation was again firmly suppressed a year or two after the declaration of the independence of the American colonies, not out of regard to their interests, but because of the necessities of the exchequer. Another century passed by, and in 1886 the revenue officers again permitted experimental cultivation to be pursued for a season or two, with the result that the ability of English farmers to produce a paying crop was again demonstrated. But the difficulty of adjusting the tax so as not to interfere with the gold mine derived from the tobacco duties was declared to be insuperable, and that is the reason why the tobacco industry in this country is limited to the preparation of the cured leaf, imported from all parts of the world.

STRIPPING TOBACCO.

Of the fifty species of tobacco the chief is known to botanists as *Nicotiana Tabacum*. In the broad-leaved variety it furnishes the famous tobaccos of Maryland, Cuba and the Philippines; the narrow-leaved form is that grown in the plantations of Virginia. It is usual to regard the oak-cured leaf of Latakia as another variety of the same predominant species. Turkish tobacco is the produce of a smaller, more delicate plant, *N. rustica*, or green tobacco; and there are other cultivated species such as the mild, innocuous leaf of the dreamy Persian. But whatever the variety, all tobacco reaches this country in packages which may not be less than 80 lb. By this means the labours of the Customs officers in the prevention of smuggling are lightened.

The Virginian leaf, which is the foundation of most kinds of pipe tobacco, is imported in hogsheads weighing not less than 950 lb. There is nowadays a great demand for mild blends, and one of the first duties of the manufacturer is to produce such a mixture of leaf of various kinds as shall produce the result aimed at in the smoking mixtures to which his customers have become accustomed. This task falls to the manufacturer, who obtains from the bonded warehouses a 4-lb. sample drawn from each of the

hogsheads which he has purchased through his broker. He takes a pipeful or two, just as a tea buyer brews for himself a sample cup of tea, and his experience enables him to write out a formula, which is passed on to the foreman of the first department.

CUTTING TOBACCO.

After the payment of the duty the tobacco is removed from the bonded warehouse, the hogshead is broken open, the contents removed in wedge-shaped slabs, and the leaves are rapidly separated from this compressed mass by workpeople of either sex, who are known as strippers. The leaves, which are very dry and brittle, and demand careful handling, are now heaped upon the damping floor, thoroughly blended, and discreetly "liquored" by means of a watering-can, or by the application of a sprayer set upon a tripod. The amount of moisture in the tobacco is determined by the simple device of weighing out a small portion before and after baking in an oven, and it is permitted by law to increase the proportion of moisture already present in the imported leaf up to 30 per cent. The moistened bulk is left overnight, and on the following day the leaves are found to have absorbed the water, and to be in a flaccid condition, which renders their manipulation easy. Those leaves which possess a stout midrib are skilfully stripped, the stalk being reserved for grinding into snuff, unless the object of the manager is to produce "bird's-eye," for which purpose the stalk is left in the leaf, and the sections of it impart to the mixture when cut the peculiar appearance which gives its name to that variety of the "weed." If "shag" be the order of the day, the stripped leaves are now placed in a frame, compressed to about a third of their height when loosely heaped, and passed beneath a guillotine knife, worked by hand or steam. By this means the mass is cut into those fine shreds which, from their resemblance to a "shaggy" beard, have derived the name given to all finely cut tobacco in the trade.

DRYING TOBACCO.

The cut heap is now transferred to a canvas frame, through which steam is gently driven, with the object of securing an even distribution of the moisture, being thence placed upon a hot plate that drives off the excess of moisture, and brings out the full aroma of the leaf. The final process consists in the removal of the shag to another canvas rack, through which a current of air passes, and the tobacco is then ready for the packers.

The cutting and drying processes are highly paid. The wage often reaches 45s. a week, and the work demands a good deal of experience and deftness. Some power cutters get through nearly a ton of tobacco per diem, but the highest grades of tobacco are sometimes "hand-cut," in order to preserve the finer qualities of fragrance in the leaf.

Much tobacco is nowadays packed into tins, but there is a large industry concerned with the packeting of pipe tobacco in papers containing 1/4 oz. and upwards. The machines which accomplish this task are ingenious contrivances, which seize the papers into which the tobacco, after being weighed out by quick-fingered girls, is dropped out of a long line of elevator buckets. One turn of a roller twists the paper into a roll, another drives two lateral cylinders on to the ends of it in order to bring the packet into shape, another folds in the ends of the paper, and another deposits it carefully in the tray, wherein it is removed to the store. The machine does all this at the rate of a packet every second, and four weighers run a race with it by weighing out their quantities with marvellous exactness at the rate of fifteen weighings per minute.

Two other forms of pipe tobacco remain to be described. The navvy and the seaman have a fancy for roll or pigtail, which is spun direct from the uncut leaf in spinning machines that do not differ in action from ropemaking. The roller is a trained workman, whose cleverness comes out in the manner in which he instinctively selects from a row of leaves upon the table those which will join most readily with the "wrapper" and "filler" already in the groove. He thinks nothing of passing a good half-mile of roll through his machine between morning and night, and from the bobbins upon which the roll is wound another workman cuts off the lengths that make up the coils in which the twist is made ready for the consumer, after being stored and then pressed for several weeks, an operation which gives to it the black colour beloved of the British workman. Another process consists in rolling the leaves into tight cylindrical masses, which are then reduced to a square form under cold pressure. These bars are then cut into flakes of greater or less thickness, in imitation of the time when the smoker cut off his smoke from a solid plug by means of his jack knife. This is the form of tobacco known as "navy cut," and there are variations of it produced by different manufacturers, such as "golden bar," to suit the taste of the connoisseur.

Cavendish or negro-head is a form of tobacco, used for smoking or chewing, the essential feature of which is that it is sweetened by the addition of molasses. It is usually manufactured in bonded warehouses. The cake or plug is produced under pressure, and may be shredded in a cutting machine so as to form "cut cavendish."

The manufacture of cigars in this country is larger than the general public might suppose, although there are no available statistics as to the percentage of imported tobacco that is turned into pipe tobacco, cigars, and cigarettes. The preparation of the cigar begins at the very outset in the stripping room, where the pliant leaves are straightened out and rolled into pads, the broken leaves, or the tobacco imported in that form under the name of "filler," being used as the inner foundation of the cigar. The operative is given so much leaf, out of which he or she is expected to produce a certain number of cigars. In the early days of British cigar making—and the industry does not date seriously from before the Crimean War—the cigar makers of the East-end of London were almost all aliens, and many of them Dutchmen. To-day the industry is largely in the hands of English or alien Jews, who develop marvellous skill in the fabrication of cigars, which are recognised as being more carefully and neatly made than many famous brands imported from the country of growth. The filler is arranged with the grain in one direction, or it would give a ragged smoke. It is

CIGAR MAKERS AT WORK.

MAKING "NAVY CUT" TOBACCO.

enclosed in a "strip," and outside this is wrapped a spiral piece of selected leaf, the end of which is neatly twisted to form the point that is removed by the cigar cutter. The filler is deftly shaped by the operatives, and the art of the workpeople is proved by the celerity with which they select from their little hoard of leaf those pieces which will blend most naturally in texture and colour. After the cigars are finished, they are sorted, boxed, and stoved, in order to mature. This operation is performed in a stoving chamber lined with zinc and protected by an asbestos ceiling, wherein as many as 5,000 boxes may be treated at one time.

The most interesting branch of the industry in recent years is that concerned with the manufacture of the cigarette, which has ousted pipe tobacco from its proud preeminence of centuries. For this purpose two forms of tobacco are used, the Virginian and the Turkish, the latter being a more delicate leaf, whose value is several times that of the American when it reached the port of entry, although the addition of the same rate of duty reduces the relative disparity. Most smokers of the present generation can remember the time when it was the universal practice to roll one's own cigarettes, and it was only when intricate machinery began to produce the finished article at a price scarcely higher than that of the tobacco itself, that the sale of made cigarettes assumed its present huge proportions. The highest forms of the cigarette are rolled one by one by hand

MAKING ROLL TOBACCO.

workers, the most skilled of whom do not aim at a larger daily output than 1,500. A more rapid process is the "push" principle, which consists in rolling the proper quantum of tobacco in a linen strip, and transferring it to the paper cylinder by means of a short wooden rod. Many workpeople turn out 2,000 each day, and at the rate of 3s. per thousand their earnings reach the respectable total of about 35s. per week. But the bulk of the cigarette manufacture is performed by steam or electrically driven machinery, which forms an endless roll of tobacco that is guided into a groove upon which there runs a strip of paper a mile long, and as it advances is pasted, cut into lengths, and in some instances packed into cartoons, with mouthpieces, tinfoil, pictures, and the like, both cigarette and cartoon having been printed with the name, trade-mark, and other announcements of the manufacturer during the journey through the machine. Some of these machines are capable of manipulating as many as 200,000 cigarettes per day, and they require the attendance of but three operatives—the skilled mechanic, the feeder, and the girl who removes the finished product to the packing tables. The addition of cork tips and other refinements is subsequently made by hand.

PACKETING MACHINE ROOM.

The manufacture of snuff is a vanishing industry. For this purpose the stalks of the leaves and other by-products are pounded in a mortar, or disintegrated in a machine which tears the material to fragments, and devices are adopted for the production of free ammonia, which imparts its peculiar pungency to the article. Tonquin bean and other aromatic ingredients are added according to the nature of the blend. The details of some of the processes of tobacco manufacture are shown in the excellent series of photographs, for which we are indebted to the courtesy of Messrs. R. and J. Hill, Limited, of Shoreditch.

The most recent figures available as to the extent of the industry are to be found in the supplement to the annual report of the Chief Inspector of Factories and Workshops. According to this

CIGARETTE MAKING.

authority the number of operatives employed is as follows: England and Wales, 27,638; Scotland, 3,399; Ireland, 2,109; total for the United Kingdom, 33,146.

Apart from the counties in which are situate the chief cities, the counties in which the industry is most largely carried on are Notts, 3,007; Somerset, 2,172; and Gloucester, 1,339. Flint, Worcestershire, Sussex, and Cambridge are credited with one, two, three, and four tobacco workers respectively. The London census for 1901 records 7,912 workers, of whom 3,238 are male and 4,674 female. Eight trade unions are recognised in England and Wales by the Labour Department of the Board of Trade, the largest being the Cigar Makers' Mutual Association, which was founded in 1832. Its membership is 1,309 males and 887 females. The Female Cigar Makers' Protective Union, formed in the Jubilee year, has a present membership of 1,290.

It is estimated that the consumption in the United Kingdom per head of the population has doubled during the last half century, from 16·3 oz. in 1851 to 32·25 oz. in 1901.

In this survey of the tobacco industry no account has been taken of the many subsidiary industries connected therewith. These include the manufacture of cigar boxes, cigarette cartoons, the printing of labels, bands, and the like, the manufacture of pipes, clay, meerschaum, briar, and so forth, and the hundred and one appliances which go to make up the attractions of the tobacconist's shop. The extent of the retail trade is sufficiently shown in the census record for London alone in 1901, which includes 3,812 tobacconists, of whom no less than 894 are of the female sex.

E. G. HARMER.

THE MALTING INDUSTRY.

Photo: Cassell & Co., Ltd.

A MALTSTER.

BEFORE the Roman conquest beer was very little known in Britain, the chief beverages being mead and cider. With the improvements in agriculture, however, a kind of ale was made from barley, and long before tea was introduced by the early East Indian navigators, beer became the general beverage not only of our own country, but also of the leading nationalities of the world.

The chief constituent of beer is malt, the production of which is the subject of the present article, an account of the various processes of beer-making being reserved for a later occasion. Malting as an industry is peculiar for its freedom from the influence of modern invention, the machinery of the malt-house at the most consisting only of apparatus for moving the grain from one place to another. The reason is easily explained. Malting is a process of *nature*, by which barley, or other grain, undergoes a botanical and chemical change. A grain of barley is of a hard tough nature, and on being cut open the inside of the corn has a firm, white, and occasionally glassy appearance. The main portion of the contents of the corn consists of starch, closely confined in minute cells, so small that even when the barley is finely ground, the starch is not free, and cannot be dissolved. The removal of these cells is one of the objects of malting, but this is not enough, as the brewer does not want starch which is unfermentable, but sugar, of a kind which can be fermented by yeast. Now starch and sugar are substances of a very similar nature, the chemical elements being the same in each, but in different proportions, so that, as we shall see, all that is necessary to produce from the starch a fermentable brewing material, is a comparatively small chemical change.

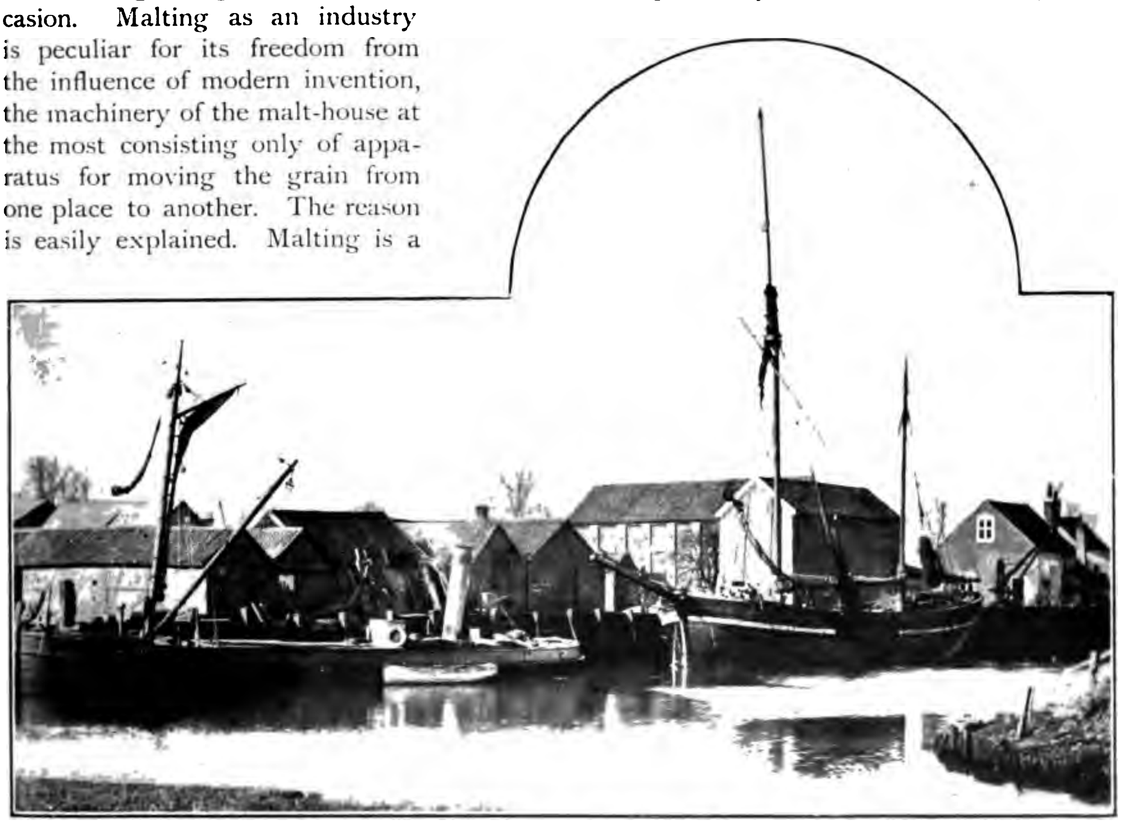


Photo: Cassell & Co. Ltd.

ARRIVAL OF A CONSIGNMENT OF BARLEY.

The objects of malting having been explained we will proceed to describe the practical means by which these objects are attained.

The maltster must first buy his barley. This he does either from farmers on the local markets in the case of English barley, or from merchants and importers, if he wants foreign material. English barley from the immediate neighbourhood generally arrives in the farmers' waggons, or, if it has to come from a distance, by rail. Foreign barleys arrive at some large port, and are then delivered to the maltster either by rail, or by water in small vessels, if the maltster is lucky enough to occupy waterside premises.

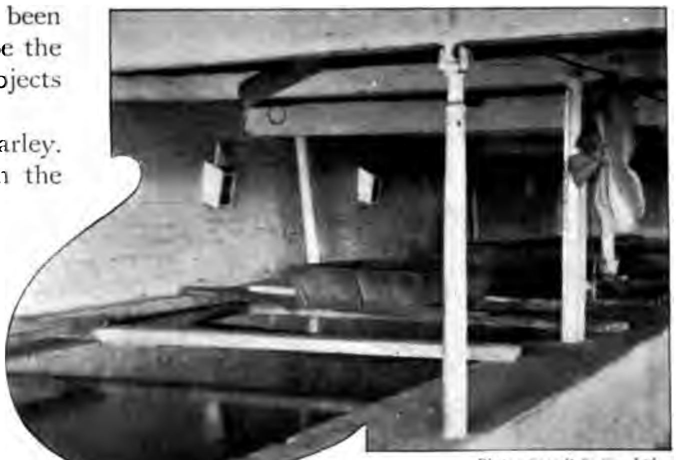


Photo: Cassell & Co., Ltd.

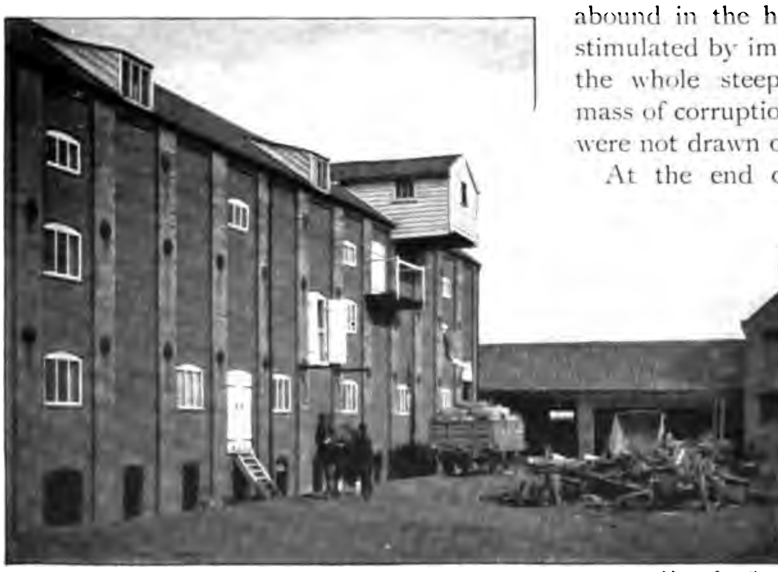
A "STEEP." THE BARLEY IS RUN IN THROUGH THE SPOUTS IN THE WALL.

The barley is now cleaned, or screened, in order to remove all small corns, dirt, stones, seeds, and any other rubbish which it may contain, some barleys, especially foreign, undergoing a considerable loss of bulk in this way.

Barleys grown in an uncertain climate, like that of England, are often insufficiently dried by the sun, and where nature has failed the maltster has to use artificial means. Such barleys are dried on a kiln, the corn being spread out on the perforated kiln floor, under which burns a smokeless anthracite coal fire. The products of combustion have no other means of escape but through the perforations of the floor and through the barley on the floor, which is thus dried and mellowed in the same way as barleys from hotter countries are dried and mellowed by the sun. The barley will now keep satisfactorily for months, and is placed in stores or bins until required for malting.

The first step in the actual malting process is to soak the barley in a cistern or "steep." This steeping is continued for two to three days according to the nature of the barley, the water being changed at intervals. Sufficient changes of water are very important, as mould and other disease organisms abound in the husks of the barley, and are stimulated by immersion, and in mild weather the whole steep would quickly become a mass of corruption if the contaminated water were not drawn off.

At the end of the steeping period the water is finally drawn off, and the corn "emptied" from the steep, and laid in a heap on the malting floor. The malting floor is a plain floor of cement or other composition, and must be well ventilated and free from cracks and hollows where corn can lie and rot, as mould is extremely dangerous at



HOW THE BARLEY ARRIVES BY RAIL. Photo: Cassell & Co., Ltd.

this stage. There are generally three or more floors to each steep, one over the other.

The corn is now left lying in the heap, or "couch" as it is called, till it begins to show signs of germination. The time needed for this naturally depends upon the weather, a few hours being enough on mild days, while in the winter it often happens that no apparent change will have taken place after a couple of days.

The couch or heap is now broken up, and the corn divided on to the different floors of the malt-house, where it is evenly spread out just thick enough for its own natural warmth to advance the process of germination. Great care must be exercised by the maltster with regard to the depth at which the growing "piece" lies, as corn too thickly heaped up soon gathers a far greater heat than will allow of its growing naturally and producing satisfactory malt, while the growth is unnecessarily checked by too thin spreading, and consequently time and money thrown away. It will be seen, therefore, that to insure even growth throughout the "piece" the corn must be quite evenly spread out, the depth being as nearly as possible the same at all points.

Photos: Cassell & Co., Ltd.

"PLOUGHING."

"TURNING" AFTER "PLOUGHING": SHOWING FURROWS LEFT BY "PLOUGHING" AND SMOOTH SURFACE AFTER "TURNING."

Let us suppose that the weather has been cool, and that the corn, having lain in the couch for twenty-four hours, is now divided on to the different floors and spread out to a depth of five or six inches. On examination, we find that the grains are all showing a small white excrescence at one end. This is the first appearance of roots, and the maltster hopes to see them all appear together, as uniformity is important at all stages of the malting process, and most of all at the beginning.

The grains are now all growing plants, and like every form of life, whether animal or vegetable, they require air to breathe, and generate heat in the process. The corns lying on the surface naturally have an unlimited air supply, and are thereby kept cool, while those below, being closely confined, tend to gather heat and to stifle themselves, the interstices between the corns becoming filled with carbonic acid gas, the poisonous gas generated by the respiration of animal and vegetable life. Thus we see that the effect of leaving the piece untouched would be first of all that the lower layers of the grain would grow faster than the corns on the surface, owing to their higher temperature, and that they would then die by the process of asphyxiation.

To counteract this tendency, and to insure even growth throughout, the piece is "turned," or "ploughed," by the maltster. The first-named process is by far the more thorough and laborious of the two. It is difficult to convey an accurate idea in black and white

of the skill required for good turning, one maltster differing from another even after many years' experience. Let us suppose that the piece is lying from one side of the floor to the other, and occupying about a quarter of the length of the floor. The maltster begins turning at the forward edge of the piece, that is to say at the edge farthest from the steep. With a flat wooden shovel, he throws upwards and forwards a small quantity of the corn, at the same time giving a peculiar twist with his wrist which scatters the grain, and separates every corn from its neighbour. Having begun at one side, he works his way across the front edge of the piece till he reaches the other side of the floor. On the part of the floor immediately in front of him there now lies a thin layer of corn evenly distributed at a depth of but a few grains. He now works his way back again across the floor, turning the next few inches of the piece forwards in the same manner, and so on to the end. This may appear simple, but the difficulty lies in the *even* turning of the piece over any amount of floor space that the foreman maltster may have directed. A piece turned by a skilful maltster has a perfectly even surface and is of the same depth throughout, while the work of the novice can easily be detected by undulations on the surface, or a gradual deepening of the corn from one end to the other. Of course, the result of either of these faults is uneven growth.

Photo: Cassell & Co., Ltd.
SHIPPING MALT.

Our piece has now been out of the steep two days, and is known to the maltster as two days old; it has just been turned for the first time on the morning of the third day. In the evening the foreman maltster, judging by the temperature of the piece and of the atmosphere, will perhaps consider that ploughing will be sufficient to keep the piece cool till the next morning. The "plough" of the maltster is merely a small piece of board attached to the end of a stick, similar to a broom-stick, which serves for a handle. The maltster pushes the plough through the piece, holding it at an angle, so that the corn is forced upwards and outwards, like the earth from an agricultural plough. This process serves to supply fresh air to the piece, and to cool it temporarily, though a ploughed piece should not be left long unturned, as its surface is furrowed, and uneven growth would soon result. During the first three or four days the white shoots on the grains have developed into rootlets, each corn having from two to four of them, though they are at present quite short. On closer examination another change is visible. The young plant has not only put out

SCREENING MALT. Photo: Cassell & Co., Ltd.

roots, but is also beginning to develop the part which would afterwards become the blade. This part, technically known as the acrospire, but familiar to the maltster as the "back," begins at the root end of the grain, and travels up under the skin of the barley-corn towards the opposite end. At the present stage it is only just beginning to be visible through the skin, but in the course of the next eight or nine days the backs work their way to nearly the full length of the corns, ploughing and turning having been carried out every day, and water sprinkled on the pieces once or twice when they have shown signs of becoming too dry to grow.

When the "backs" are about three-parts of the length of the grains, the maltster checks the growth by ceasing to sprinkle the pieces and heaping them up rather more thickly. This soon results in the rootlets withering off and the backs ceasing to grow farther along the corns.

We will now pause for a moment in the description of the malting process to consider what has taken place during the germination of the corn. Minute life organisms, known as enzymes, have been at work, and one of them has had the special function of destroying the cells which confined the starch in the original barley, and a corn at this stage crumbles when broken open. Another enzyme called diastase has the power of converting starch into sugar, and Nature has provided for the nourishment of the young plants by secreting in the grains a quantity of this diastase, which would have gradually converted all the starch of the grain if the plant had been allowed to grow. However, when the piece is withered off the body of the grain is still starch, but there is present in it also this enzyme, which in the brewer's mash-tun will convert it into a fermentable sugar.

Let us now return to our "piece," which is at present withering off on the malt floor. The pieces on the other floors have been grown in exactly the same way, and they are now all loaded on to the kiln, which is similar in construction to the barley drying kiln already described. The kilning lasts for about four days, the temperature gradually rising. The malt, having been periodically "turned" on the kiln, is now thoroughly dry, and has a pleasant biscuity flavour. All that now remains to do, is to separate the rootlets or "culms," as these are useless to the brewer. This is done by passing the malt over a screen, or sieve, which allows the culms to fall through, and the finished malt is then kept in dry stores till it is sent away to the brewers.

The above is a brief description of the malting process as generally carried out; though a new system, which has found favour in America and Germany, is being introduced. This consists in growing the corn in revolving cylinders, through which air is passed, either moist or dry as required, and of a suitable temperature; but the system has not been generally adopted.

G. E. M. COWELL.

A CARTLOAD OF BARLEY. *Photo: Cassell & Co., Ltd.*

BLAST FURNACES, DERWENT IRON AND STEEL WORKS.

THE MANUFACTURE OF IRON AND STEEL.

THERE were workers in iron three hundred years before the Trojan War; and even the wild hill people of Africa and India have long been adept, in primitive fashion, at converting iron into steel by the addition of carbon. The art of smelting and casting iron was familiar to the Sussex iron workers before body armour fell into desuetude, and it was at the great furnace at Lamberhurst, on the Kentish border, that the balustrade encircling St. Paul's Cathedral was cast, at a cost of £11,000. The use of coal, instead of wood, for smelting tended to drift the iron trade to Staffordshire and the North. Here vast stores of minerals were almost to hand, and coal abundant. Invention and capital were by-and-by the helpers of labour, and Birmingham, Sheffield, Leeds, Manchester, and Glasgow developed into great cities, practically on coal, iron, and steel used in the making of the tiniest pen, the sharpest knife, or the most formidable ram for battleship.

There is a touch of romance in every industry, and the steel trade has not been without its exciting incident. The finest steel in England was originally made by Hindoos, and, though of extravagant price, gave little satisfaction as to its quality to Huntsman, the Yorkshire clock-maker. His watch-springs were for ever breaking, but he discovered, and kept secret, a process of steel-making that fulfilled his requirements. His fame spread, but no man could fathom his mode of manufacture, till one winter's

Photo: By permission of the Wigan Coal and Iron Company, Ltd

PLATFORM OF STEEL MELTING FURNACES.

night a beggar piteously sought for shelter in the works. The vagrant was admitted, and coiled himself within the warm area of the forge to sleep; but he slept with one eye open, and eagerly noted every move of the steel-making, for he was an iron-founder in the disguise of a tramp, and he took Huntsman's secret out in his busy brain, beneath his ragged cap.

BESSEMER CASTING PIT, YORKSHIRE STEEL AND IRON WORKS, SHEFFIELD.

A RANGE OF CARBURISING FURNACES.

But this process, the production of cast steel by the fusion of converted bar iron of the required degree of hardness, did not content the investigator Bessemer. Restive with inventive genius, he set up a factory at Baxter House, St. Pancras, and experimented, often unsuccessfully, but never disheartened. He erected a converter, and discovered that by forcing streams of air at high pressure through the bottom of the fireclay lined vessel filled with molten metal he could make steel! Nobody believed it; and one ironmaster, going to the British Association at Cheltenham, said incredulously: "Why, there's a fellow come down from London who says he can make steel from cast iron without fuel! Hah! ha—hah!" What Bessemer did, striving against failure and contempt, was to produce pure malleable iron at a reasonable price. But he wished to go further: to make steel serviceable and inexpensive; to produce pure iron with a small percentage of carbon to harden it. He finally succeeded, and Bessemer steel became indispensable on railway track and in a thousand industries.

But steel is impossible without iron, and though pessimists declare that some of our methods are antiquated, and that foreign competition is ousting us from distant and

even home markets, iron manufacture is still a considerable industry in the kingdom. There are blast furnaces in Cleveland, Durham, Scotland, West Cumberland, Lancashire, Yorkshire, Derbyshire, and other counties. Indeed, at night the glare from the furnaces is seen on many a countryside. The tall brick structures, with their iron-plated parapets and turrets, once lighted, are seldom allowed to cool. They are the red-hot centres of unremitting toil; and the fillers are ever busy on the circular ways at their summits. The waggons, laden with

Photo by permission of the Wigan Coal and Iron Company, Ltd.
TEEMING STEEL FROM LADLE.

calcined iron ore and coke, are lifted eighty or one hundred feet high, and toppled into the yawning fiery cavity, in which the iron is liquefied, ultimately running from the base of the furnace into the sand moulds, in the shape of "pig" iron, so called because the sand gutters into which the metal flows bear some "resemblance to a sow with her pigs sucking." The metal, in its crystallised state, is like the stubborn Englishman. You can break it, perhaps; but you cannot bend it. Consequently it is placed in the puddling furnace, and the puddler, with his long iron rabble, or bar, moves it hither and thither in its melted condition till impurity has been worked out of it, and it is malleable—wrought practically into subjection.

The conversion of iron into steel by the Bessemer process is not only beautiful in display, but characterised by simplicity. The converter, which made the inventor famous, is a large oval vessel with a big spout. It is lined with firebrick, road drift, or ganister, and moves on an axis. The pig iron, melted in a cupola, is run into the converter, and then a strong blast of air technically called a "blow," is sent through the fluid mass. The effect is wondrously picturesque. The combustion is so fierce that the metal is swiftly brought into intense heat, and freed from impurity. Out of the mouth of the converter rush a myriad sparks and brilliant tongues of flame; and in the depths of the vessel there is the toss and bubble of the lambent iron, which throws off the most beauteous tints of crimson, blue, and gold. Close by, in the almost blinding glare, stand the steel workers, statuesque, gauging the effect of the "blow." The slightest hesitation on their part may spoil the material; but they act in the nick of time. The converter is dipped, turned downward, and the necessary quantity of spiegeleisen added to the molten metal, with which it chemically combines, producing steel. The converter is lowered again by hydraulic power, and its contents, white as driven snow, flow into ladle and into mould, assuming the form of the ingots applied to the manufacture of rails, bridge work, cranks, wheels, boilers, marine engine shafts, and many articles of trade and household use. For instance, the Bessemer process has revolutionised the railway tracks of the world, from the old iron roads to the long, sinuous ways of gleaming steel. One English railway alone, making its own rails, turns out thirty thousand tons yearly. The ingots are taken out of the furnace to the mouths of the revolving rollers in the rail mill, and mangled first into thick bars of steel; and then compressed, elongated, and shaped, till they are passed on from the last pair of rollers to the circular saws, which cut and turn them to thirty feet lengths, perfect rails, ready for the track.

Though Bessemer steel is so widely used, not only in this kingdom but abroad, the making of crucible steel is not obsolete. Huntsman's discovery of melting in the pot, with a chemical flux as his secret, led to the production of steel of the finest

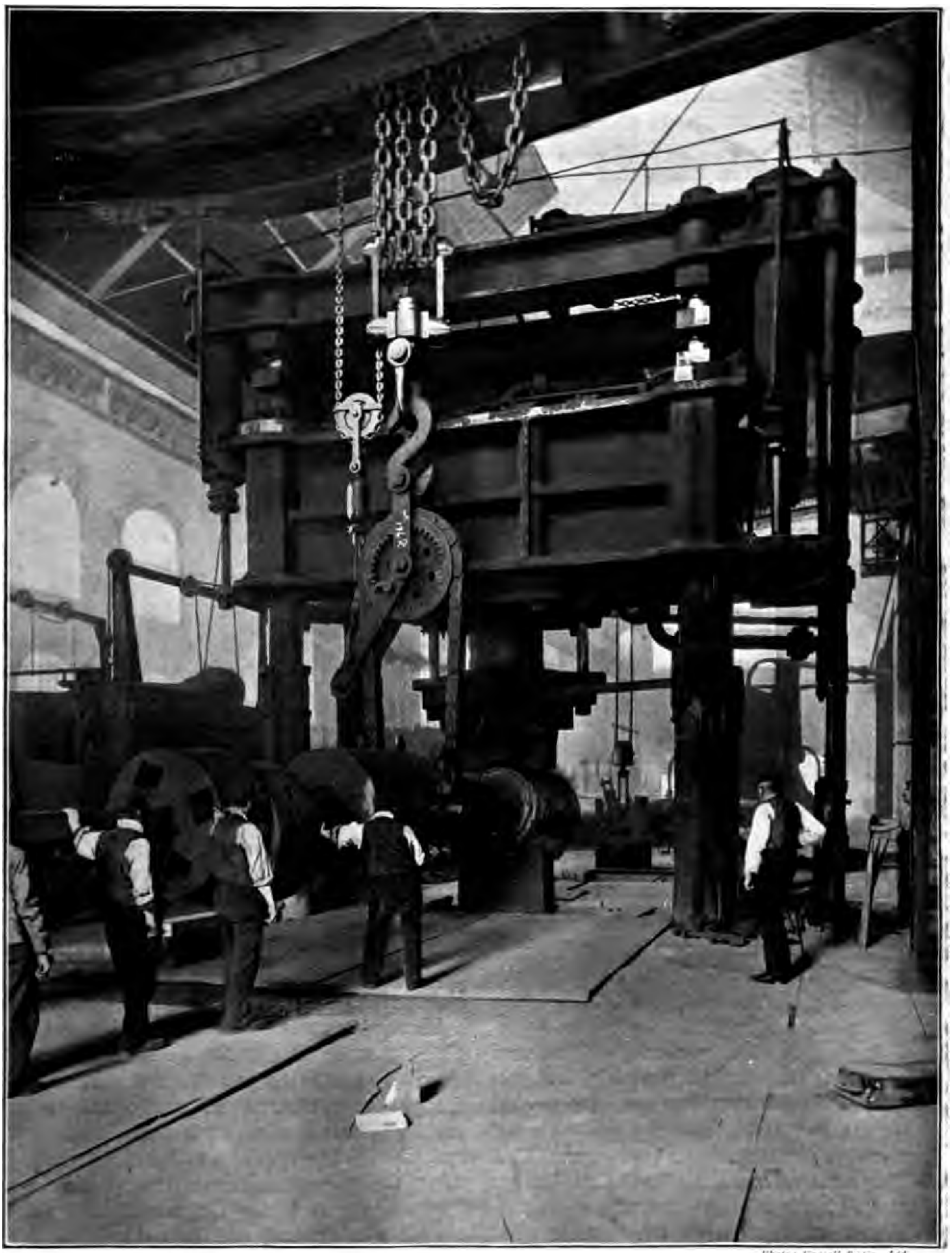


Photo: Cassell & Co. Ltd.

THE NASMYTH HAMMER AT WORK AT THE ATLAS STEEL WORKS, SHEFFIELD.

quality; and steel of the finest quality from the crucible is still absolutely necessary in the manufacture of a thousand things, from big guns to music wire for pianofortes. Much depends, of course, on the quality and also on the manipulation of the steel used for all cutting instruments; and it is only by a careful process of heating and cooling, of hardening and tempering, that the knife-blade, lancet, or razor are made fit to receive their indispensable edge on the grindstone. Bessemer, Siemens, Martin, Armstrong, and others have revolutionised the steel manufacture by new processes, that new properties have been found in it by the addition of silicon, manganese, chromium, tungsten, and nickel, and that the scientist and the manufacturer have by no means exhausted the limits of discovery in the realm of steel.

Meanwhile, there are two chief processes of steel manufacture—the Bessemer and the open-hearth process. It is contended by

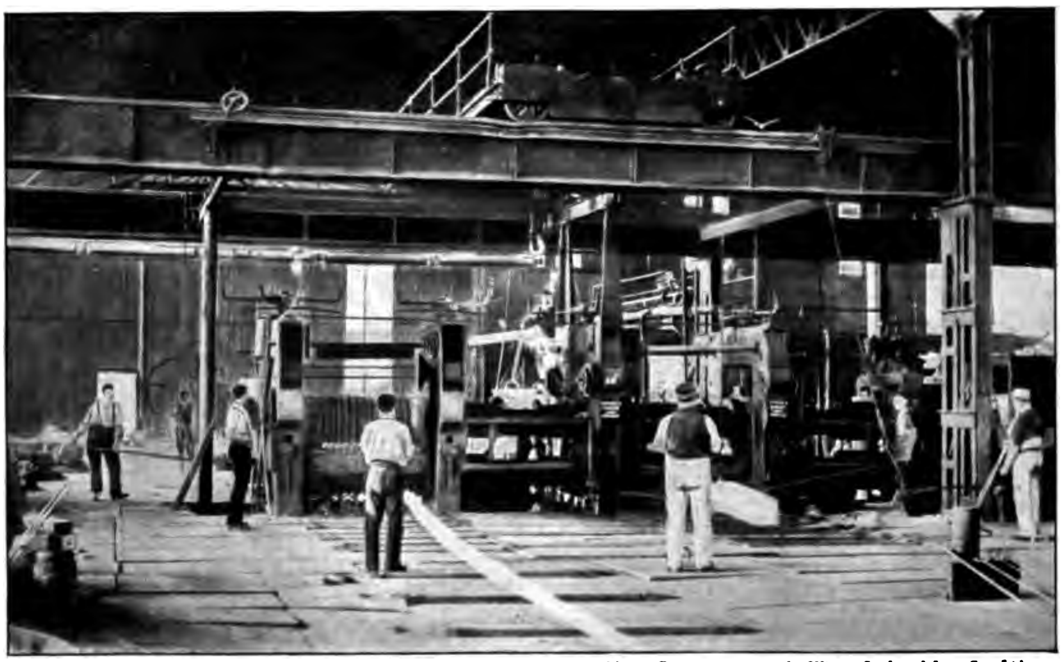


Photo: By permission of the Wigan Coal and Iron Co., Ltd.

ROLLING STEEL RAILS.

Yet there were clever handicraftsmen in this direction in the sixteenth century, for one writer says, "Though plain knife-making was very ancient in Yorkshire, yet Thomas Matthews, on Fleet Bridge, London, was the first Englishman who, *quinto Elizabethæ*, 1563, made fine knives."

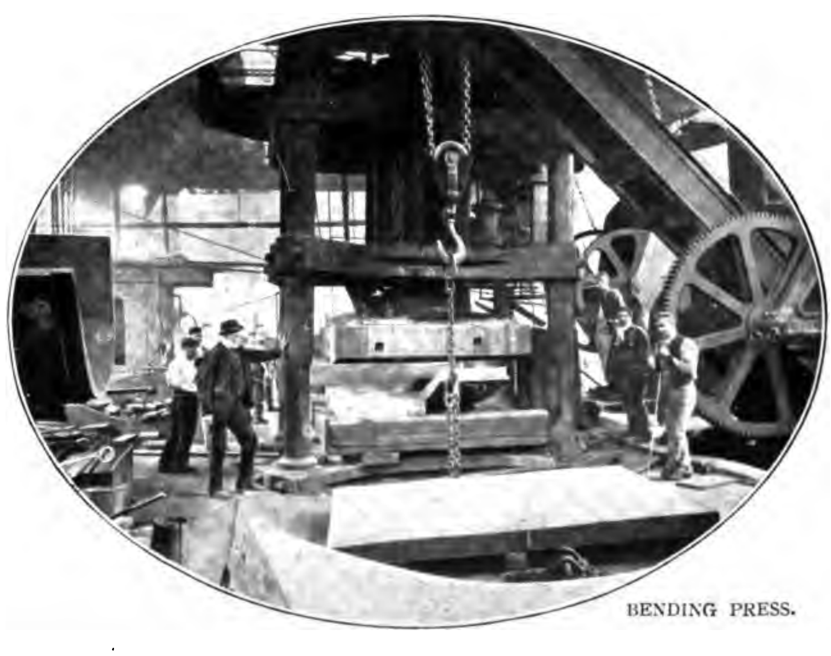
If you speak to an authority on iron and steel production, he will probably tell you that quality and intensity are now sought in steel; that "allotrophy and carburisation of iron are the passwords of to-day, and that their significance has been blended by showing that the power of iron to retain carbon in solid solution depends on the peculiar allotropic form in which the iron exists." These fine words have been created out of half a century of experiment. They indicate that experts that the rapidity of the Bessemer process is only obtained by a large initial outlay, and by considerable waste of metal; and that the open-hearth process, invented by Siemens, though giving a higher yield of metal, takes a much longer time, and involves a heavier expenditure in labour. The complaint is made that in the Bessemer process there is practically no time to examine the product; whereas in the open-hearth process the mode of action is more deliberate, and the quality of the steel can be ascertained during manufacture. Attention is consequently given to the improvement of the open-hearth process, and one development, already in vogue, is "the use of the fluid metal from the blast furnace, mixer, or cupola, to avoid loss of time, and oxidation by air

ARMOUR-PLATE MACHINE AT WORK.

during melting in the Siemens furnace." Martin, whose name is often coupled with that of Siemens as the co-inventor of the open-hearth process, was rather concerned in the mixture of the metals. To Siemens the credit of the utilisation of the open-hearth, and the regenerative gas furnace in steel manufacture was undoubtedly due, and both he and Bessemer were deservedly knighted for their inventive genius.

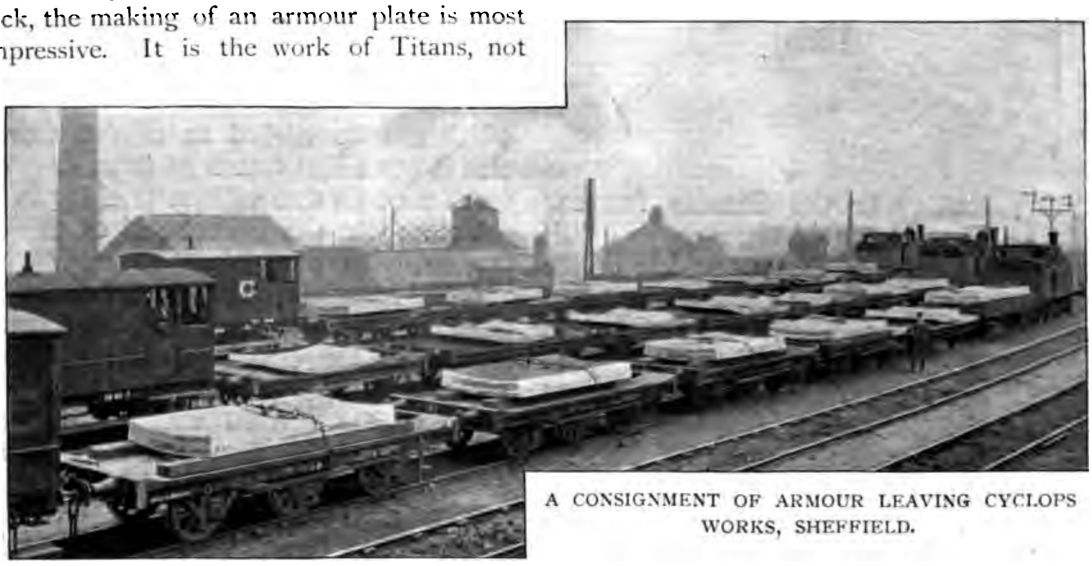
Turret ships originated in America, big guns from compressed steel at the Manchester Whitworth's, torpedoes in Austria, and submarine boats from naval ingenuity in the United States, in Great Britain, and in France. The Victorian era was remarkable for the increased application of iron and steel to constructive and manufacturing purposes. Perhaps the most unique object to which steel has been put is seen in the gigantic machinery, the mammoth rollers, ponderous steam hammers, lathes and borers with which it squeezes, shapes, cuts and penetrates itself. There is a huge Nasmyth hammer at the Atlas Works in Sheffield, which can be worked to such a fraction that it can either flatten an ingot or gently touch a watch face without breaking it.

Vulcan was the ancient god of fire, and the protector of workers in metals, and Sheffield has appropriately topped the highest point of its Town Hall with his muscular figure. In the smoke-clouded districts of Attercliffe and Brightside, Vulcan also, in the shape of the modern workman, big and sinewy, toys with iron and steel. He is absolutely impressive when he handles an armour plate in the Cyclops Works of Messrs. Chas. Cammell and Co., Limited, a Sheffield firm noted for its armour plate making, in which it is ever availing itself of scientific discovery and new processes.



BENDING PRESS.

It was the boast of Whitworth that his guns would send a shot through any plate. It was the boast of John Brown and Charles Cammell that their plates were invulnerable. The steel-faced plate, the plate of homogeneous steel, and the plate of specially hardened steel, have superseded the original one of iron, and the trial between projectile and naval armour still goes on, not only in England, but in Germany, France, Russia, and America. Of whatever material, intensified by modern research to resist attack, the making of an armour plate is most impressive. It is the work of Titans, not only muscular themselves, but capable of controlling and directing gigantic machinery to a nicety.



A CONSIGNMENT OF ARMOUR LEAVING CYCLOPS WORKS, SHEFFIELD.

The steel required for the manufacture of the plate is cast in ingot form, forged into a slab by hydraulic pressure, and then placed in the huge furnace for heating, and remains in the fire from eight to thirty hours, according to the thickness of the plate needed. Then comes the colossal task of getting the mighty plate from the interior of the furnace to the grip of the rolls for thinning and shaping. Many men and adroit appliances are in requisition for this purpose. Expert observation is made through the furnace peephole. The plate is "done to a turn." The men, safeguarded with sacking, body-plates, and protecting shields, group around the furnace door. At a signal it slides open, and the workshop, or armour-plate mill, is filled with intense heat, and with a dazzling radiance that lights up the remotest corner of the building. On the breast of the furnace fire lies the leviathan plate in a white heat, lapped by blue and golden flame. Just beneath the wide mouth of the furnace the trolley—a low-wheeled waggon—has been pushed. The travelling cranes, set in motion by the engines beyond, swing the heavy chains and the mammoth pincers towards the furnace mouth. The pincers grip the plate like the claws of vultures, and slowly but surely drag it on the trolley, which is forced to the rolls twenty yards away. These heavy revolving forces grip the plate, as it seems, almost stealthily, and move, as it were, by mysterious power. The engine, out of sight, drives by steam a big flywheel and a series of cogwheels, which revolve, and rotate a long shaft that sets the rolls in motion. Like merciless but imperturbable giants, they pass the plate to and fro with apparent ease, till they have reduced it to the required thickness. The plate is then bent to its proper curve at the press, and undergoes numerous heatings and treatment, after which it is cut to shape in order to fit it for its allotted place on the ship.

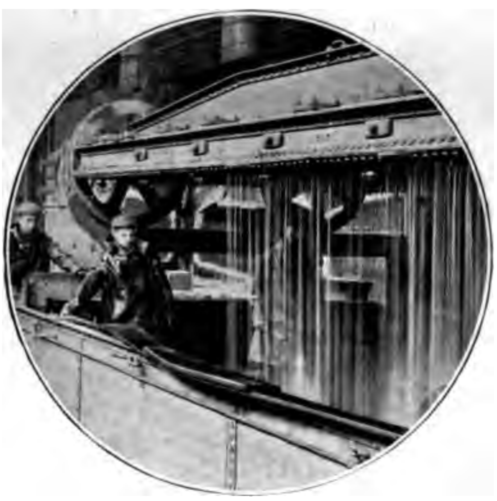
Nasmyth not only introduced his big hammer, but held that the production of steel laid the foundation of the arts. Anyhow, one prefers to look at steel rather in relation to constructive than destructive purposes, and there is absolutely no limit to its use. It is necessary in one form or other

in ship, on railway, and in great bridge; it means employment in the workshop and comfort in the home; it has revolutionised building, with girder and column; it is invaluable in electric traction by overhead railway or the "Twopenny Tube"; and the bicycle, the motor car, and the flying machine owe their adoption to iron, the "King of Metals," and the coquetry of science, which has converted it into steel.

Our exports are comparatively small in proportion to the total output, inasmuch as iron is plentiful in Europe, America, and more distant lands, and nearly every industrial country manufactures and applies its own iron and steel. Yet the makers of the United Kingdom need not be ashamed of their workers, either for dexterity of handling or quality of material, though to keep pace with American enterprise and ingenuity they need to continue modernising the open-hearth process, which finds a ready market owing to the steadfast quality of its steel. Makers should strive also to come nearer in price to their oversea rivals. As it is, they import yearly seven million tons of iron ore, they produce over nine million tons of pig iron, more than a million tons of wrought iron, and five million tons of Bessemer and open-hearth steel. And this output represents, in direct and indirect labour, an enormous factor in the nation's prosperity.

JOHN PENDLETON.

(Except where otherwise acknowledged, the illustrations accompanying this article are from photographs kindly supplied by Messrs. Chas. Cammell and Co., of Sheffield.)



WATER DOUCHE FOR HARDENING STEEL ARMOUR.

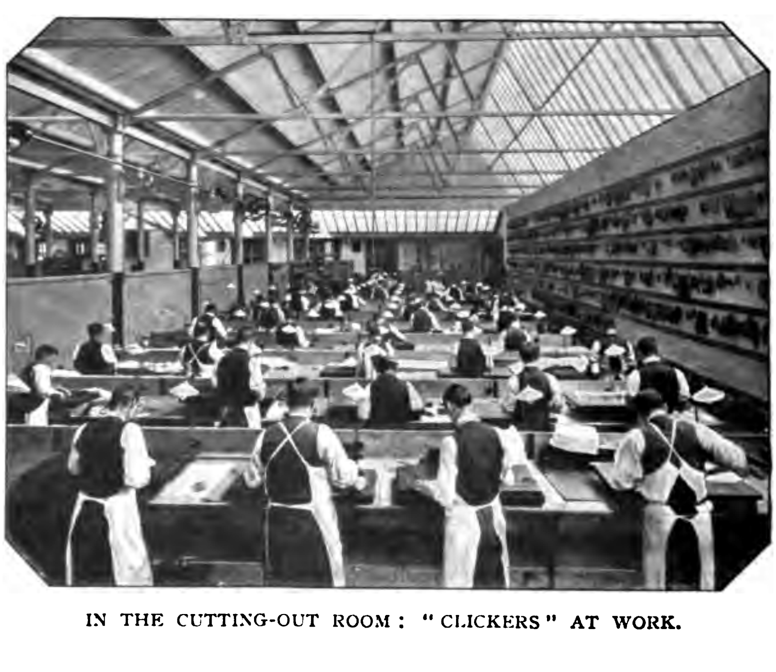
BOOT AND SHOE MAKING.

SAWYER LEATHER-MEASURING MACHINE.

THERE are in Great Britain and Ireland more than 2,000 shoe factories, some of which employ over a thousand hands; and it is estimated that there is a total of 110,000 workpeople engaged. Leicestershire, Northamptonshire, and London have collectively in round figures 1,000 factories, employing 27,000, 20,000, and 10,000 respectively. A great number of the 350 factories of London, situated principally in the East-End, are small, and employ a large number of out-door hands, many of whom are poor Jewish immigrants. There are a number in Leeds also out of a total of 4,000 employed. Nearly as many hands are employed in Norwich as in London, and Glasgow and Bristol have each about 2,500; whilst Kettering and Stafford employ in round figures some 3,000 each, on men's and women's goods respectively. Other shoe centres employing over 1,000 workpeople are Maybole, N.B., Bramley (Yorks), Higham and Rushden (Northants), and Manchester and district—where there are some 1,500. There are also something like 40,000 retailers.

Until recently one could say that the different centres of the trade were characterised by men's, women's, children's, "turn" shoes, and army boots; but recent developments have altered this, and while it is still true that Northampton is principally noted for best men's work, Leicester for women's of a medium class, Stafford for the best women's, Leeds and Bristol for heavy men's, Norwich for "turn-shoes" (referred to later), the villages of Northamptonshire for army boots, London for variety, and Manchester for slippers, these distinctions are now less marked.

The making of a factory shoe begins with the pattern-maker, and his starting point is the last. Curiously enough, there is no such thing among last-makers or cutters of upper patterns as a standard, and one of the consequences of this is that a good deal of mystery



IN THE CUTTING-OUT ROOM: "CLICKERS" AT WORK.

attaches to the office. By "standard" I mean a fixed relative size of one portion or another to the length. Enterprising pattern cutters have started in business as designers to the trade, but with limited success in this country, although, strange to say, the practice of employing such an outsider is the general one in the United States. With the last in hand, made by a last-maker to precise instructions, a pattern-maker clothes it with paper or with canvas, as a dressmaker would fit a model. A certain size is made up first and offered to the factor or retailer, and orders are taken from this sample for the various sizes of the same pattern, before others—above or below it—are graded from the original. The upper patterns consist of a more or less numerous set of parts, and in leading factories the reproduction of these various parts in sizes is performed on a machine, which is a complicated adaptation of the "Pantograph" with which in our youth we enlarged the photographs of our relatives—to their horror. Upper patterns are cut in zinc, sheet-iron, or card-board, but in the latter case the patterns are afterwards bound with a thin, square-edged bead of brass or mild steel.

So far as patterns for soles are concerned, they are only of such a temporary nature as will be sufficient for the smith to shape his knife to. Bottom leather is "died out" by a "pressman" by means of a shaped knife under the buffer of a powerful press; whilst the upper leather is cut out by hand on a board. Linings, facings, and button bits are cut out by either process, the first of these several at a time. The cutter is called a "clicker," because in using his slender knife he makes a clicking sound. In view of the amount of skill that is required from the "clicker" in cutting up a skin to the best advantage from patterns of different sizes and shapes, it is surprising how poorly he is paid, the average wages only approximating to 30s. per week. It would seem simple enough to an outsider to drop a pattern upon a skin and cut round it, but every clicker worth his salt knows which way the leather will stretch when worked into an upper, and he has to so adapt his cutting of the skin as to get the best results.

IN THE "CLOSING" DEPARTMENT.

The area of skins can be taken by a machine such as is depicted in our illustration. This is the type of machine used by the firm of Smith, Faire & Co., of Park Vale Works, Leicester, manufacturers of women's and girls' goods, to whom I am indebted for the photographs from which the accompanying engravings were obtained. What the clicker leaves after cutting from his pattern is known as offal, which, when not suitable for cutting tongues, toecaps, etc., or for making children's

shoes, technically known as "nurseries," is sold to offal dealers who have a connection with "nursery" men. All instructions for the manufacture of goods are set forth upon a "tag" like a long luggage label. A foreman, upon completion, usually tears off the portion of the ticket relating to his department and files it. This ticket enables the office to keep trace of what takes place from the entry of an order into the factory to its delivery in the stock room.

The upper leather having been cut and assembled with the linings, etc., corresponding, it is despatched to the "closing" or machining room. This is where uppers are fitted together, first attached by paste and then sewn deftly by young women on sewing machines—which are of a variety of types. It is necessary for the expeditious closing of uppers for several operators to perform different parts. One will sew the seams in the linings, another will put in backstraps, a third will attach the vamp, and so on; and to facilitate this the modern machine bench is made in sections, with a trough at the back, into which the work drops as it is reeled off. Here are the old types of single sewing machines with one needle, somewhat like the one with which the housewife is familiar, two-needle vamping machines, twin-needle zigzag machines, and those making three or four stitches simultaneously, and machines which trim the edges of the uppers with knives whilst the needle is doing its work. The sections of bench are placed end to end, so that the trough is continuous, and underneath is fixed the shafting, which drives the separate machines at the will of the operator. The work is passed from one part of the room to another by means of a wicker trolley

A BUSY SCENE IN THE "BOTTOMING" DEPARTMENT.

on castors, the idea here being, as in other departments, for the process to be continuous until completion.

The upper leather must be "skived," which means that a wedge-shaped slice is removed from each of two edges which have to be joined, so that the thickness of the two shall not exceed that of the other parts of the upper. Most of the upper leather "skiving" is performed on a machine which carries a thin, rapidly rotating circular knife, the feeding of which is very similar to that of a sewing machine. After "skiving," then "fitting"; and the tendency to-day is to do as little "fitting" as possible; partly to save labour, and partly to avoid the use of paste or other adhesives liable to germination if

goods are kept in stock, or which might render the upper less pliable in wear. Where "fitting" is reduced to a minimum a higher skill is required on the part of the machinist.

WORKING THE REECE BUTTONHOLE MACHINE.

One of our illustrations shows the Reece buttonhole machine, which is capable of cutting, stitching, and finishing 6,000 holes per day. Eyeletting is performed on another high-speed machine, a well-known type of which will punch and eyelet at the rate of 180 holes per minute. There are also in this department rapid machines for beating level the seams of closed uppers, for turning over skived edges, rounding them into a bead, and a machine which automatically cuts and shapes the beading which underlies "button bits." It is here also that machines attach buttons, and 10,000 per day is not too many for an operator to attach.

The necessity for having work done rapidly upon expensive machines, which can only be purchased by men with capital, has led to the "boot upper ornamenter" to the trade. In every large shoe town there are men who have a fixed charge for doing everything necessary in the closing room, whether in the way of ornamenting uppers by stitches or perforations, or attaching uppers to the bottoms by means of heavier sewing and stitching machinery. They send vans round to pick up and return work, and it is also sent to them from the outlying districts and returned by an early post or parcels despatch.

Leaving the closing room, we come to the "bottoming department." There are several means of attaching uppers to bottom leather. There is the rivet of brass or iron, the wood peg, and thread stitch. The "Blake" sole sewer sews right through, the stitch lying in a channel ploughed in the outer sole, and showing inside the boot on the inner sole, needing a sock to prevent contact with the wearer's foot. The "Blake" was introduced in the early 'sixties, and has never been displaced. In the "turn-shoe" the upper whilst inside-out is attached to a single sole, by machine or by hand, with a curved needle. Finally there is the "hand-method principle" welted boot, which has a welt, as in hand-sewn, attached to both upper and inner sole. The welt is attached to the outer sole by a "fair stitching" machine, which also sews in a channel, leaving on the welt those regular pearl-like stitches which, when "pricked up," enhance the appearance of the machine-made boot. This form of attachment is, moreover, nearly equal to that of the hand-stitched article.

It is necessary that every part which enters into the bottom should be cut to the right size and shape, and should also be moulded under great pressure. So far as outer soles are concerned, the leather is first cut in strips wide enough for the full length of the sole, and for the purpose of "dieing out" a deep knife is used, so that the operator may lift it from cut to cut until he has a number of soles, before removing it from the press block of wood to empty it.

HAND-METHOD LASTING MACHINE.

Boys chop on a press the "lifts" which go to make up a heel, and they also assist adult operators at numerous machines. They build heels, the several portions of which are held to-

gether by nails plunged into them whilst pressed in the moulds. They cut smooth the front of the heel, generally speaking, before it is attached, and it is possible to perform this operation at the rate of 1,000 heels per hour. They feed the "counter" or "stiffener" skiving machine, sole-splitting and "evening" machine, and serve the one which, in addition to attaching the top piece of the heel, studs it with those rivets which ornament as well as add to its wear resistance.

There is still a large amount of lasting done by hand, but the work is sub-divided so that one operator does not perform the entire process of lasting. In rivetted work he is a "puller over," or "laster," or "getter off," or "tapper up," and where machine lasting is practised there is generally a team of men working together grouped around the machine. The "puller over" works at a spike or "sturt," on which the last is placed bottom upwards. The lasts may be of iron, wood with steel plates on the bottom, or wooden lasts with merely a plate at the heel seat, according to the kind of work in process. He picks up the upper, laid close to his hand, inserts the last, paying particular attention to its position so as to bring the toe-cap straight, places the inner sole upon the last bottom and temporarily attaches it thereto by tacks—forepart and heel.

With his pincers he pulls the upper over at the toe and tacks it down, repeating this at the joints inside and out, and at the heel. More than this is done in some cases, but this suffices. He lifts the last, upper, and insole, now united, from the stand and lays them down ready to the hand of the machine laster. We will assume that it is a "hand method" Consolidated laster—a machine which, prior to the introduction of a royalty system, whereby the machines are leased for a premium and so much per pair lasted, was sold for £300. In the hands of a skilful operator, whose wages are as high as 50s. per week, this machine pleats-in the upper, and tacks it to the inner sole, using pincers having a straight or oblique pull, according to the will of the operator In the case of "hand method" goods, after lasting as described above, the lasting tacks

IN THE FINISHING ROOM.

EDGE SETTER AT WORK.

are withdrawn when the upper is secured to the "lip" of the inner sole by a cord.

The welts are sewn in by a machine having a curved needle, and which feeds the welt from a roll, like tape. This welt is afterwards beaten to make it stand out squarely. The surplus upper leather is trimmed with a knife. The space between the upper leather which lies on the bottom of the last is filled in evenly. The filler may be cork, felt, or scraps of leather cemented in. The outer sole, channelled and moulded to the shape of the bottom of the last, is now cemented on. Fair stitching then follows. The channel is rubbed down and the bottoms are levelled under pressure in a machine carrying rollers conforming to the shape of the sole. The operations of lasting, sewing, stitching, and "rounding" are performed whilst the sole leather is in a mellow, damp condition, and in welted work the last remains in the boot until it is "finished," which process takes place soon after the boots are dry enough to allow the sand-paper — mounted on a roll— which scours the bottom to do its work effectively. The boots leave the "lasting department" on skeleton racks, which run on castors, and are just a little wider than the length of the sole. They carry three or four tiers of boots.

In the shoe - finishing department, the machinery would seem to have originated in the brass-finishing shop; the cutters which pare the heel and sole edges before the bottoms are scoured, the polishing mops, pads, and brushes, all having had their counterpart in Birmingham years ago. Everything here revolves at a high rate of speed—2,000 to 3,000 revolutions per minute; and the dust and parings which fly rapidly from the boots as they are trimmed or scoured, are removed by fans in pipes attached to each individual machine, and having connection with other pipes leading to the outside of the building. Heels and edges are set, after being coloured, with a hot iron and wax. The bottoms are, in a large number of cases, literally painted with a brush and "slosh"; the "damped down" process of the old shoemaker is still retained, but it is more costly. The goods removed to the stock-room have all disfiguring marks removed from them by girls, and, if of a high-class character, are "treed and ironed." They are then "sized" (polished) and boxed, or, if of a commoner quality, are tied in pairs by the machine shown in the illustration. The hot irons of the "edge-setter" have the backward and forward sweep of the human arm, long experience having shown this to be the only satisfactory movement. This motion causes great vibration, making it one of the most trying of machines.

MARTIN W. WRIGHT.

TYING-UP MACHINE.

THE ABERDEEN GRANITE INDUSTRY.

ALTHOUGH Aberdeen is universally known as the Granite City, comparatively little is heard of how the glistening masses of stone are torn from their beds in the bowels of the earth, and cut and hewn into magnificent monuments and graceful colonnades or cornices for the embellishment of our public buildings. One can readily understand how a tolerably soft material like sandstone is wrought into delicate tracery for the beautifying of a cathedral window, but it seems difficult to realise that a material so hard as granite can be cut into sections like a Dutch cheese, and carved into a Corinthian column, a delicately draped figure, or a garland of flowers. Nevertheless, this is done. It is true the labour involved in carving a block of granite is much greater than that required for working freestone, but the result is a hundred times more lasting. Ruskin, wielding a master pen, wrote of the many-tinted "stones of Venice," glowing beneath an azure sky, but deplored the many signs of decay which marred their beauty. The stones of Aberdeen have not the transitory brilliance of hue admired by Ruskin, but, on the other hand, they are as imperishable as those of ancient Egypt, and will doubtless remain untouched by time when the glories of the "Queen of the Adriatic" have crumbled into dust. The granite spires and towers of Aberdeen, gleaming in the summer sunshine, have earned for it the title of the "Silver City by the Sea."

Photo: Cassell & Co., Ltd.

RUBISLAW GRANITE QUARRY, ABERDEEN.

Within recent years an enormous development has taken place in the Aberdeen granite industry, owing principally to the introduction of improved means for quarrying and working the material. Machinery for cutting granite has undergone a complete revolution, and no architectural or monumental detail is considered too elaborate for reproduction in this material. To those unconnected with the industry there are, broadly speaking, only two distinct varieties of granite, grey and red, but in reality, of each of these there is a multitude of tints and sizes of grain, according to the quarry, or particular part of a quarry, from which the stone is obtained. The greys vary from a deep blue to a silvery tint, and the reds from a rich carmine to a salmon pink. Of the original formation of granite the most generally accepted theory is that the rock, with its constituents of felspar, quartz, and mica was heaved up through the earth from a great depth, molten and impregnated with vapour, and the cooling process being slow

gave time for its various parts to resolve themselves into the distinct grains which make the stone so beautiful. In Aberdeenshire the principal grey granite quarries are Rubislaw, on the outskirts of the city, and of which most of it is built; Kemnay, which furnishes excellent material for finely-dressed work and statuary; and Dyce, Dancing Cairns, and Persley, all in the vicinity of the city. Of the familiar red variety the principal quarries are at Peterhead, while a darker shade comes from the Hill o' Fare on Deeside, and Corrennie on Donside, the latter being a pretty shade of pink when left unpolished.

The granite industry of Aberdeenshire employs altogether about 9,000 men, including quarriers, paving-stone makers, builders, monumental sculptors and polishers; and those dependent upon it may be estimated at about 45,000. The manufacture of "paving setts" is an important and rapidly growing branch of the trade. In Aberdeen alone there are over eighty granite cutting yards. Let us take a brief survey of the stages through which a block of granite passes from the time it leaves the quarry till it is despatched from the mason's shed in a finished state.

Although good rock is sometimes found quite close to the surface of the ground, the best quality of granite is, as a rule, at a fair depth. In appearance a large granite quarry is not unlike the crater of an extinct volcano, except for the busy scene within, the men looking like pigmies on a vast "floor," perhaps two hundred feet beneath the ground level. Boulders of fantastic shapes lie scattered about, one huge mass of detached rock, many tons in weight, giving evidence of a successful blast. Square blocks of stone of the sizes required by the builder or monumental sculptor, are detached from the mass by means of drilling a series of holes into which steel wedges are driven and the stone split up. A steam drill will sink into the rock fully five feet in half an hour, a process which was formerly almost a day's work for three men. The larger blocks of stone are raised from the "floor" of the quarry to the surface by powerful steam cranes, while the smaller stones and waste are conveyed to the top by an ingenious contrivance known as a "blondin." A blondin is an aërial railway, the name, no doubt, being borrowed from the daring rope-walker who crossed over Niagara Falls. Traction engines are frequently used for the transport of building material from the quarries, but for the removal of large blocks for monumental purposes, teams of horses are usually employed. On arrival at the stone-cutting yard the great block of granite is deposited in a convenient part of the dressing shed, or placed ready for removal to the saw.

Now, it may be found necessary to cut a six or seven ton block of granite into several slices or sections, to be used as bases or steps for a large pedestal, or perhaps as a recumbent monumental slab. If this be the object in view, the stone is lifted on to a bogey, which is run on rails right underneath the saw. The saw is a sheet of steel from six inches to nine inches wide, about a quarter of an inch thick, and a few feet longer than the stone required to be sawn.

Photo: Cassell & Co., Ltd.

A 7-TON BLOCK OF GRANITE AT THE DRESSING SHED.

This huge blade is suspended above the stone with its edge parallel to it, and being swung with a pendulum-like motion by powerful machinery, the saw slowly but surely cuts its way into the granite. Unlike an ordinary saw, however, the granite saw has no teeth, and having an edge a quarter of an inch thick, the question will at once arise, how can a blunt instrument of this description cut through several feet of one of the hardest stones in existence? Well, the saw might swing to and fro for years, with no appreciable effect, if it were not for the application of an abrasive in the shape of grit or grains of chilled metal, exactly like bird-shot, upon which the edge of the saw works. Water being, of course, applied to prevent heating, a mixture of shot and powdered stone is formed, constituting a kind of sludge which is constantly ladled into the saw-cut by the man in attendance. The process of slicing up a large block of granite is necessarily a gradual one, a depth of $2\frac{1}{2}$ inches per hour being considered good work. This means that to saw through a block five feet in depth would take twenty-four hours, or nearly three working days. Nevertheless, the use of the granite saw saves an immense amount of manual labour, and if the operation is carefully carried out, the sawn surface scarcely requires to be touched by the dressing hammer, and is ready for the carving shed or the polishing mill.

When placed on the polishing carriage, as the machine is called, the granite passes through three distinct stages before acquiring the beautiful gloss so much admired. The first medium used is the shot already referred to, but of a finer grain than that used for sawing. The shot is rubbed over the surface of the stone with revolving metal rings, until smoothness is obtained. Emery powder is then applied, which produces a dull polish. Last of all putty powder is rubbed on with felt attached to the revolving rings, and the polishing process is complete. A bed of granite 23 feet in length will be polished in two days. To polish mouldings, iron plates are made to fit the curves of the stone, and the process is carried out with the mediums described, but applied to the mouldings by a machine called a pendulum, the action of which is explained by its name. Columns and urns are made to revolve on lathes, and the gritty substances being applied with the irons and felt, they, as it were, polish themselves. When it is necessary to polish work carved in relief, as is almost invariably the case with orders received from French architects, men known as hand-rubbers are employed. The hand-rubbing process is, of course, much slower than polishing by machinery, but the same methods are used.

The carving of Aberdeen granite was revolutionised a few years ago by the introduction of the pneumatic tool. The pneumatic tool had been in use for a considerable time in England for caulking purposes, but the people of the United States were the first to apply it to granite, the pioneers of this idea being, it is asserted, Scottish-Americans. Broadly speaking, a pneumatic tool is a small cylinder within which a piston is driven by compressed air. The motion of the piston being communicated to an ordinary carving chisel, that tool when in use comes in contact with the stone at the rate of from 1,500 to 2,000 strokes per minute, very many more times, it will be admitted, than a workman could accomplish with an ordinary hammer. The air is generated by a steam compressor, and conveyed by metal pipes to the carving sheds. These pipes are tapped at intervals, and the air carried by indiarubber tubes to the tools held in the hands of the workmen. When directed by a skilful handicraftsman the pneumatic tool will accomplish work of the most minute and elaborate description. When applied to the stone it rapidly "eats" away the superfluous material, and flowers, fruit, heraldic shields, regimental crests, and designs of a like nature, are quickly reproduced on the hard granite, with as much fidelity of detail as could be accomplished in Sicilian marble. For statuary the pneumatic chisel is equally useful, and it is also extensively applied in the cutting of inscriptions. There are pneumatic surfacing machines for dressing large stones, but only a few are as yet in use in Aberdeen. The axe and the bush-hammer are the tools most extensively in use for fine dressing. When the dressing of a stone is done

Photo: Cassell & Co., Ltd.

HOW THE GRANITE IS POLISHED.

Photo: Cassell & Co., Ltd.

PNEUMATIC CARVING TOOLS BEING APPLIED TO A CELTIC CROSS OF GREY GRANITE. THIS STONE IS OVER 17 FEET IN LENGTH.

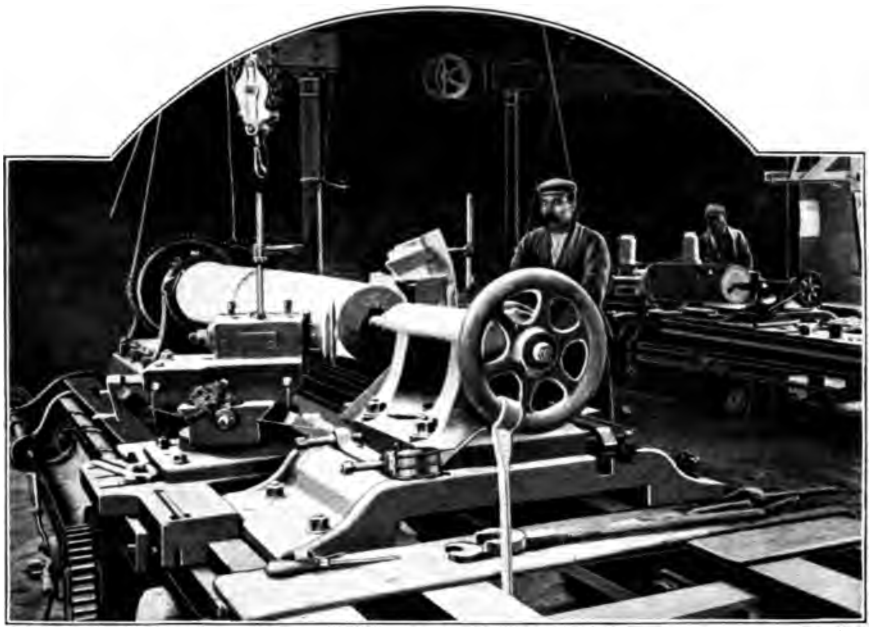


Photo: Cassell & Co., Ltd.

TURNING A GRANITE COLUMN.

entirely by hand a considerable amount of labour is necessarily expended before the roughness of the quarry gives place to the smooth surfaces and the sharp and true edges required by finished work.

In order to make this article complete it is necessary to say a word about the turning of the large granite columns which are a feature of so many of our public buildings. A square stone of the necessary dimensions is procured from the quarry as already described, and in the stone-cutting yard this is roughly hewn into a cylindrical form. It is then ready for turning. The lathe is a powerful one, as columns about sixteen feet in length and about three feet in diameter are by no means uncommon. When the cylinder of stone begins to revolve on its axis, a series of circular steel cutters come into action, and, striking the rounded surface obliquely, the graceful contour of the classic column is rapidly evolved, and a surface is obtained which is ready for polishing.

Aberdeen granite work is exported to almost every part of the globe, although within the last twenty years or so the almost prohibitive tariff imposed by the United States government has considerably diminished the trade with that country. On the other hand, however, there is a rapidly increasing business being done with the Australasian colonies, and also with South Africa, and there is every reason to expect that in the latter country there will be a still greater increase of trade.

One feature of somewhat melancholy interest, in connection with the Aberdeen granite industry, is the large number of military monuments which have been despatched to South Africa, amongst them being those placed over the graves of Prince Christian Victor, General Woodgate, and gallant Dick-Cunyngham. The Prince Christian Victor memorial is a simple cross of Celtic design, cut from a block of granite quarried in the neighbourhood of Balmoral Castle. One of the last orders given by the late Queen Victoria was for a carved Celtic cross of the same stone, which has been erected at Balmoral in memory of her second son, the Duke of Coburg, and there also, set up by the tenantry on the Balmoral estate, is a massive monolith of Crathie granite in memory of the late Queen herself.

In addition to the trade in the British colonies, there has been a steadily increasing demand on the Continent for polished Aberdeen granite; France, perhaps, being the best customer. French architects seem to prefer the red granites, and some magnificent sarcophagi in this material have been despatched. An interesting example of a

French monument is that to Charles Garnier, the famous architect of the Paris Opera House. The whole of the granite work of this memorial was executed in the yard of Messrs. Alex. Macdonald and Company, Limited, the pioneers of polished Aberdeen granite. It is scarcely necessary to speak of the home trade. Everyone in this country has seen some bank, assurance office, or other public building embellished with the product of the granite city, its shining surface defying the grime and smoke of a London atmosphere. Within the last ten years or more, such has been the demand for architectural granite work, that the Aberdeenshire quarries, extensive as they are, have not been able to furnish a sufficient supply, and although it may appear very like the proverbial carrying of coals to Newcastle, it is nevertheless a fact that large quantities of foreign granite are imported into Aberdeen, in the rough state, principally from Russia, Norway, and Sweden. None of the foreign material, however, can compare with the home article. As the deposits of native rock are practically inexhaustible, and the development of the quarrying industry is going steadily on, it is confidently anticipated that in a few years there will be a large enough output of Aberdeen granite to meet all demands.

Apart from architectural and monumental work, Aberdeen granite is rapidly asserting its superiority as a bridge-building material —the widening of London Bridge being one of the latest examples of its adoption for this purpose. In conclusion, one last word may be said in regard to the artistic possibilities of granite work. For several years a granite-cutting class has been conducted in connection with the Aberdeen School of Art, the students being taught to model their design in clay before reproducing it in the more permanent material. The object of this class is to still further improve the quality of the work done in the stone-cutting yards, by inculcating a taste for art in the minds of the younger generation of workers in granite.

VICTOR MITCHELL.

Photo: Cassell & Co., Ltd.

SETTING UP A GRANITE MONUMENT.

Photo: W. J. Dewe(?), Great Yarmouth.

THE SEA FISHERIES OF GREAT BRITAIN.

THE Sea Fisheries of Great Britain have a just claim to rank with the oldest industries of the country, having been followed with increasing vigour and profit for several centuries past. The story of their growth is intimately associated with the history and expansion of our Empire, for by training and accustoming large bodies of men to a sea life the fisheries have played no mean part in building up and consolidating the vast dominions we have acquired as a direct result of our supremacy of the seas.

Since the days when ships were first recognised as important factors in the defence of our shores, and were equipped and manned by private enterprise to strengthen the royal ships of the navy and assist in repelling the king's enemies; to the time when, under Nelson, the nation possessed a formidable navy and obtained a complete and final mastery of the seas by defeating all rivals, the fisheries have taken an important part in providing some of the best fighting material the world has ever seen. It was chiefly from our fishing villages and seaport towns that the men who were the backbone and leaven of the very nondescript crews who manned our wooden walls were drawn.

Nor are the fisheries fulfilling a less important part to-day. Thousands of the fine class of men composing them are enrolled in our Naval Reserve, and should at any future time our shores be threatened by a powerful foe, there is every reason to expect the fishermen's response to their country's call will be as prompt as that of other classes of the community.

STEAM TRAWLER WITH TRAWL DOWN.

It is computed that some 87,000 men and boys are constantly engaged in the fishing industry afloat, while a further 8,000 occasionally take part in it. Being constantly exposed to danger, the fisherman learns to remain cool in circumstances of peril, to use his judgment, to develop powers of endurance and resource, and also acquires

the faculty of doing the right thing at the right moment—qualities which go to make up the highest form of seamanship, and which, as seen in our handy man, command at the same time our wonder and admiration. The immense benefit the nation derives from the possession of this important industry, looked at from the national point of view, is the result of our being surrounded by shallow seas. The North Sea, from which more

EMPTYING THE NET.

than four-fifths of our fish comes, is nowhere so deep but that the cross on St. Paul's Cathedral would be exposed—if it were possible to transport that handsome structure and drop it down in the German Ocean—while in other spots frequented by the fishermen, a goodly portion of the dome would also appear above the waves, and in certain places on the Dogger Bank the west door would scarcely be covered. If it were otherwise, the trawl fisherman's attention would perforce be confined entirely to the coast limits, instead of his being able, as is the case, to let down his trawl practically anywhere he wishes within the limits of the North Sea.

The fishing industry is divided into two distinct branches, being known as trawling and drift-net fishing. The first method of fishing is the more important, and is, again, divided into two branches — fleeters and single-boaters. As the name implies, the former work together in fleets, under the control of fishermen selected on account of their great experience, and called admirals. These men direct the movements of the fleets and choose the ground to be fished over, issuing their orders in the daytime by flags and at night by rockets.

The single-boaters, on the other hand, possess a roving commission and are free to select their own fishing grounds, and so long as they justify this freedom of action by results are not interfered with by their employers. The men commanding such vessels resort to all sorts of methods to conceal the grounds they have been working in the event of one of them meeting with

A CATCH.

goes as far north as Iceland, and works wherever the depth of water and the nature of the bottom permit of successful trawling being done. The takes of fish on the Iceland grounds are sometimes enormous. The illustration on page 68 gives a good idea of the immense catches made; the fish shown in the net representing only a fourth of the total haul, which was so great that it had to be taken on board in instalments. This splendid catch of fish was made by a steamer after towing her trawl net for four hours only, and consisted of two hundred trunks of fish weighing in the aggregate upwards of seven tons.

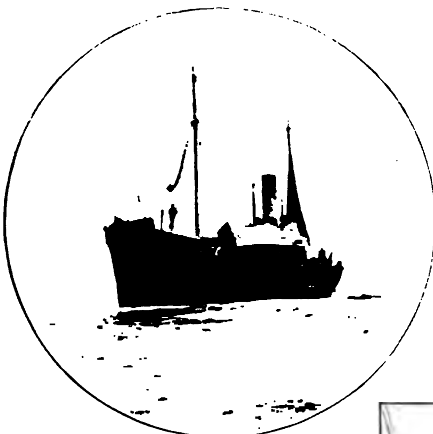
The lives of the men employed in both these branches of trawling are ones of incessant toil, the net being hauled and lowered at stated intervals, night and day; but of the two, fleeting is the least popular, as the voyages, lasting twice as long as

exceptional luck. Should, say, the steam trawler *Amelia* arrive at Grimsby with a good catch, next time she leaves port she is certain to be shadowed by a dozen other vessels intent upon gaining her secret. This the *Amelia's* skipper will do his best to guard, and will, perhaps, steam away in a totally different direction to the region of the North Sea he is actually bound for. Then, when night comes on, he will choose a favourable opportunity to cover his lights, and by steaming back on his own tracks endeavour to shake his pursuers off. If successful his secret may remain secure for another trip, but, sooner or later, it is certain to be discovered, and he will then find himself in company with twenty other vessels, all intent, like hungry vultures, in securing a share of the spoil.

The fleets of trawlers are entirely engaged in supplying the London market, and for this purpose a regular service of carriers, whose duty it is to run out to the fleets and collect the fish caught by the vessels composing them, has been organised. In consequence the grounds over which such fleets can fish are restricted, being governed by the distance the carrier is capable of steaming in a given time to catch the Billingsgate Market. On the other hand the single-boater, with her ice-lockers well filled,

FERRYING FISH FROM TRAWLER TO CARRIER: AN ACCIDENT.

those of the single-boaters, entail longer absences from home. The crews have also to face the risks incurred in ferrying fish from their own vessels to the carriers, a proceeding, in bad weather, accompanied by a considerable element of risk, a danger the crews of single-boaters are not called upon to face. A great many lives have



FISH CARRIER BOUND FOR MARKET.

been lost in this way or from small boats during the last few years. In the days of sailing smacks the voyage sometimes extended to ten or twelve weeks, the minimum being eight weeks, but since the advent of the steam trawlers the length of the voyages has been governed by the state of the coal bunkers.

As some idea of the extent of the trawling industry, it may be interesting to state that the two premier fishing ports of Grimsby and Hull have a capital of at least four and a quarter millions invested in steam trawlers, while the total value of the fish landed in the United Kingdom in one year (1900), taken at the average price of 1½d. a pound, was £9,688,000. Such a food supply, close at hand, to a country largely dependent on outside sources for the means of existence cannot be over-estimated. An average year's catch would thus, by a comparison of weight, be equal to a flock of 10,263,220 sheep and 1,047,267 cattle.

The risks of the fisherman's calling are eloquently testified to by the roll call issued by the Board of Trade, which records the fact that during the last ten years 1,790 men have been lost through their vessels foundering or being missing, while the individual losses account for a further 796. The greatest loss of life of recent years was in the great gale of February, 1894, when 200 men perished in a single night, the majority being lost through their vessels foundering with all hands.

It is amongst the fleets of steam trawlers that the hospital vessels of the Royal National Mission to Deep Sea Fishermen have worked with so much success, sharing alike the danger and disappointment of the smacksman's life. These vessels are admirably equipped, and possess small hospitals capable of accommodating six to eight patients needing nursing as the result of

BOATS COMING UP TO PUT FISH ON CARRIER.

accident or illness, and are so up-to-date as regards their surgical equipment as to possess the Röntgen Ray apparatus. The Society's fleet of vessels all bear the words "Heal the Sick" on their port bow, and "Preach the Word" on their starboard one, and these few simple words eloquently express their mission. The surgeon, who combines the dual office of doctor and missioner, can generally count upon having a busy time each morning attending to his patients, one of the most plentiful causes for his skill being poisoned fingers and hands resulting

from pricks from fish bones during the process of cleaning.

A good story is told of a West of England clergyman who once got himself into an awkward fix. He was addressing a congregation at a fishermen's meeting, and with the object of adapting his remarks to his hearers used various nautical similes. He spoke of the noble figure of the captain navigating his ship through narrow, winding channels, abounding in rocks and strong currents, and described in detail the difficulties of the voyage, with all the eloquence he could muster, even repeating some of the imaginary captain's orders, and thus working his audience up to a fine suspense. At last the vessel was in the most imminent peril, with rocks and breakers ahead. And now "What shall we do? What shall we do?" he called out; and a voice from the congregation replied, "Bless your soul, guv'nor, that captain of yourn can't do nothin', for he's sailing his ship starn foremost." From all of which it is evident that it is well for landsmen to resist the temptation to embark upon nautical metaphor and from attempting to sail imaginary ships in the presence of experts.

A BIG BAG OF FISH.

The monotony of the fisherman's existence is indescribable, being only broken by the unending task of hauling and lowering the trawl, a process in which every man naturally takes the keenest interest, since he shares in the profits of the voyage. Even with this semi-gambler's spirit of uncertainty entering into his work, it must often be difficult for a fisherman to take any interest in the trawl and its contents, for in winter time the process of "pawing" in the net on an icy cold night, which is done entirely by hand, followed by a further spell on deck to clean and pack the fish away, entailing perhaps an hour and a half of the hardest work imaginable, with frequent duckings of sea water, is enough to damp the spirit of the most buoyant nature. Yet, in spite of all the drawbacks and hardships of his calling, the average fisherman is possessed of a Mark Tapley fund of good spirits, and though he may return below too dog-tired to remove his sodden clothing before turning into his bunk again, his next summons on deck will be met with a cheery response. The more successful a trawler is, the harder becomes the work of her crew. Probably the most bitter disappointment a fisherman is called upon to endure is, on hauling his net, to find it has been rent to pieces by some obstacle on the bottom, and that the fish for which he has worked so hard have escaped, entailing the abandonment of his well-earned rest below until the damage has been repaired.

The names of the principal fish caught in the trawl are plaice, haddock, cod, halibut, turbot, and soles, the kind taken in the greatest quantity being the haddock, and the next the plaice. These fish all frequent the bottom of the sea, and are caught by the net sweeping along and embracing them within its meshes.

The drift-net fishermen are engaged in the capture of surface fish, such as the herring, pilchard and mackerel, the method employed being in all cases the same. The herring fishery is by far the most important, its yield in one year amounting to £2,177,836 sterling. The fishery commences in July off the Orkney Islands, whither the Scotch and English boats proceed to meet the shoals. As the season advances, the fish work their way further and further south, until in October they arrive in large quantities off Yarmouth and Lowestoft, remaining until

TUGGING IN A DISABLED TRAWLER.

A GIGANTIC CATCH OF FISH : GUTTING FISH IN THE STREET.

just before Christmas, when they totally disappear until the following year. The type of vessels engaged in the herring fisheries are known as luggers, and are equipped with nets capable of stretching out nearly three miles. The plan followed is to lay these nets out in a continuous line with a buoy attached to one end of them, while the other end is fastened to the lugger itself. At stated intervals a buoy is attached, and the net allowed to float away with the tide. Occasionally such a number of herrings become entangled in the meshes of the nets that they are carried down to the bottom by the weight of the fish caught. A catch of herrings landed at Yarmouth on one occasion, taken in a single night, realised £180, and must have contained somewhere in the region of a quarter of a million fish.

A lugger's nets and equipment are worth £350, and in the height of the season, off the East Anglian Coast, it is no exaggeration to say that between 5,000 and 6,000 miles of nets are laid out, watched by 18,000 to 20,000 men and boys. The number of herrings landed in a recent season totalled up to the enormous number of 2,136 millions; and as an illustration of what these figures mean it may be pointed out that such a catch was sufficient to permit every man, woman and child in the United Kingdom making a breakfast off herring once a week throughout the year.

The annual catch of mackerel takes place off the Scillies and the South of Ireland, and yields a quarter of a million sterling to the wealth of the country, while the Cornish pilchard fisheries produce £25,000 a year, and the sprat fisheries £18,000. Shell fish account for another £437,000, and may be said to conclude the list of important sea fisheries.

It is difficult to state the number of persons directly or indirectly depending upon the treasures of the sea for their livelihood, but enough has been said to show that they form, from more than one point of view, a very numerous and important body of men.

FRANCIS H. WOOD.

Except when otherwise acknowledged, the illustrations accompanying this article are from photographs and original drawings kindly lent by the Royal National Mission to Deep Sea Fishermen.

SCOTCH WOMEN CLEANING FISH, ABERDEEN. *Photo: G. W. Wilson & Co., Aberdeen.*

THE POTTERY WORKERS.

THE pottery workers of Great Britain at present number 70,000, of whom about 25,000 are women and children. When to these figures are added the much larger number of those engaged in other branches of ceramics, including red bricks and tiles, white-glazed bricks, fire-bricks, and all classes of sanitary goods, the extent of the industry will be more fully realised.

Two-thirds of the domestic ware produced in this country is sent out from the small group of towns adjoining Hanley and Stoke, and usually classed as the "Staffordshire Potteries." In this district has been centred for many years the best experience and the most able craftsmen of the trade; so that, through the traditions of several generations, the manufacture has arrived at its present high condition of excellence. As in the case of some textile industries, the best traditions of the craft have been handed down from father to son and from mother to daughter. For, it may be noted, in pottery work deftness of hand and lightness of touch afford admirable opportunity for the employment of women and children. In many processes these are occupied to the entire exclusion of men, and with the most satisfactory results.

In order to afford some idea of the general characteristics and condition of the potter's craft, we cannot do better than venture upon a short visit to one or two typical factories.

A BUSY SCENE IN THE GLOST KILN YARDS, BRITANNIA POTTERY, GLASGOW.

On entering at the wide iron gates, we are confronted by the timekeeper's office, at which every worker registers his entrance. Small workshops and lofty machine-rooms seem to fill up the enclosure in apparently irregular confusion. Here and there an assistant is crossing from one shop to another with some piece of ware to be matched. We find that on the ground floor, where we now stand, we are brought into contact with three distinct

branches of the work: the raw material is being prepared, the manufactured goods are being fired, and finished ware is being packed for delivery.

Here are huge lorries bringing in heavy loads of the raw material to be prepared and made plastic for use. The white lumps of china clay from Cornwall, the grey and irregular masses of plastic clay from Dorsetshire, the quartz-like cubes of salmon-coloured felspar from Sweden, heaps of black flint boulders from Dieppe, loads of saggar marl from the immediate locality—all these are gathered together to contribute to the complete formation of earthenware or china.

As we follow the drivers we find them unloading their burdens upon great heaps of similar materials, from which supplies are taken as wanted. Here are great octagon tanks into which a bespattered worker is shovelling the various ingredients to be ground and agitated in water, and looking within we see hundreds of gallons of a kind of thick white cream churned up by rotary paddles. This, when consolidated, will form the plastic material of the ware.

This creamy substance is pumped into large box-like receptacles, having many partitions, between each of which canvas bags are fixed. These retain the clay, allowing the water to filter through. In these "filter-presses," as they are called, the clay is made supple and fit for use. We see the men unbolting the wooden trays which form the sections of these boxes, while others are removing the canvas bags from the plastic clay, peeling them off to be washed for future use. The clay within is rolled together like dough, and next thrown into the "pug-mill," which is neither more nor less than a huge sausage machine. From the lower end of this the consolidated clay exudes in a long square stream ready to be formed into ware, as we shall see presently, on the upper floors.

"THROWING."

MILLING AND PUGGING CLAY, BRITANNIA POTTERY, GLASGOW.

We are tempted, on passing, to glance into a large, beehive-looking shed or building, where the glowing fires within light up the interior. This is the "hovel," and within the space seems to be filled by the tall, conical furnace or "oven." Here a fireman appears to be recklessly shovelling unlimited fuel into sundry openings in the circular wall of the oven. It is difficult to realise that packed within at the present moment are thousands of pieces of incandescent ware now being embellished and perfected instead of destroyed by their fiery ordeal. Like some all-devouring monster whose hunger is insatiable, the radiant "fire-hole" greedily consumes the apparently bountiful supply. But there is absolute method and accuracy in all that is taking place. Not a trifle more fuel is allowed when the fireman's

experienced eye tells him, by the glowing heat of the interior, that the glaze on the surface of the ware will have become fused and brilliant. Quickly he handles a long iron rod, waiting till, with a heavy crowbar, an assistant has removed a small brick from the doorway of the oven. Through this opening he inserts the hooked rod, and deftly draws forth the test piece all glistening and radiant. Watching the texture and colour as it cools, he is able to assure himself that his judgment has been correct. The fires are allowed to burn down, the openings are closed, and in some thirty to forty hours the finished ware will be drawn out smooth and shining in its perfect form.

We now ascend to the upper floors, where the materials are converted into the various forms we have seen below, and in the "Thrower's shop" a new revelation awaits us.

The thrower whom we here see producing such graceful shapes and delicate outlines has but his hands and fingers for tools. With these alone he is able to evolve things artistic and beautiful from the shapeless clay which he handles. Sitting astraddle before a shallow triangular wooden tray, he takes a lump of the plastic material and throws it down upon the small revolving table before him, to which it adheres.

PRESSING.

As it rapidly spins round he wets and clasps it between his two wet palms, shaping it quickly into a cone. Then, plunging his thumbs within, the form of a rough vessel appears as if by magic, before we are able to see how this strange evolution has taken place. By gentle manipulation of his fingers he next appears to lead the plastic mass upwards into outlines and shapes of any form he wills, until we are inclined to believe that the process must be so easy that we ourselves could accomplish it.

We now enter the "Pressing shop" or shed. Here each worker, batting out on a plaster table a large sheet of soft clay, lifts it into a hollow mould made of plaster, pressing it with a pad into all its outlines. In a few hours the porous mould which supports the clay within will absorb the moisture, and can be removed, the dish or other object still retaining the desired shape. In this way all vessels are made which have not a circular form.

IN THE MODELLING ROOM, BRITANNIA POTTERY, GLASGOW.

Further on, in what is known as the "Jollying room," we obtain an insight into the manufacture

of plates and cups. Simple yet rapid is the process here carried on. The clay so readily assumes the finished shape that the eye can hardly follow the action. Some of the machines used work automatically, the workmen being only required to place the ball of clay upon the revolving table of the machine, which in a few seconds smooths and flattens it into a pancake-like piece. When this process has completed itself, the workman deftly lifts the cake of clay upon a revolving mould, which is shaped in the form of the inside of the plate. Slightly moistening the surface, he sets the machine in motion. This brings down upon the outer surface of the clay a tool which removes all superfluous substance. In the course of a few seconds the tool rises again automatically, leaving the finished clay

MAKING PLATES AND SAUCERS AT THE BRITANNIA POTTERY, GLASGOW.

plate upside down upon the mould. Both together are lifted out of the revolving cup which has held them firm, and transferred into the outer room until the moisture is removed.

When thoroughly dried and examined, the ware is taken to the "Placing room," where it is packed into large, oval, fire-clay boxes, termed "saggars." These protect the surface from dust and scorching during the firing. As soon as each saggar is filled it is borne away to the oven. Eighteen or twenty are piled on each other in columns or "bungs" as closely as possible till the whole interior is filled, and, after the entrance is bricked up, the fire is started.

When again cooled, the oven is opened and the saggars removed to the "Biscuit warehouse." Seated amidst piles of ware of bewildering variety are a number of women dressed in white overalls and head-gear, who rapidly examine and dust each piece, clinking them noisily against each other to detect any which are cracked. Other assistants constantly remove them in sets, as required, to the "Printing shop."

Designs engraved on copper plates serve for the decoration of most earthenware in this stage. The colour, moistened with oil, is spread over the hot copper; then with a knife and a rubber all is removed except that retained in the engraved lines.

Laying a moist sheet of tissue paper on the engraving, the printer runs it through the roller-press. This transfers the design to the paper, which is now handed to the transferrer. Quickly, with a huge pair of dressmaker's scissors, she snips away the superfluous paper, fitting the design to its place on the piece of ware, and with the butt end of a long roll or pad of flannel vigorously rubs the paper on to its position. Plunging

this object into a large tub of clean water, the paper is easily removed, the design remaining upon the ware.

Time will not allow us to follow it through the drying and slight firing required to remove the oil, before it reaches the "Dipping house."

MAKING TOILET, DINNER, AND FANCY WARE AT THE BRITANNIA POTTERY, GLASGOW.

Large tubs, apparently filled with whitewash; benches and shelves covered with long boards supporting rows of cups, pots, or other articles, all alike as two peas; "dippers" and their assistants in long white overalls, with respirators over their mouths—these are the chief features that strike us as we watch the glazing process. There is nothing strange or mysterious about it. Simply the seizing of the piece in the fingers and the plunging of it into the tub of creamy-looking wash, the shaking off of the drips, the replacing of it on the board to dry—that is all; but, like many simple things, it is not an easy matter to the uninitiated.

Again to the drying-room, then into the saggars once more, on the way to those ovens which we saw on entering; then, finally, after firing and cooling, the ware makes its way to the huge warehouse for sorting and cleaning.

Of the simpler and cheaper goods there is little more to be said. Their vicissitudes are at an end. Not so, however, with the

PRINTING AND TRANSFERRING.

majority of wares. Two, three, or even four firings, with intervening processes of embellishment, are needed for the most elaborate. Coloured lithographs may be transferred on the glaze; edges may be gilded; raised fretwork may be added under the gold; subjects may be painted by hand in enamel—each or all of these may combine to complete the artistic effect. After the last fire, the gold is scoured with fine sand to bring out a dull "matt" surface, or burnished in parts with an agate to a brightly polished texture, and finally passed away for approval before packing.

Such are the complex methods involved in producing high-class pottery, and the skill and experience involved taxes the best efforts of thirty or more separate artisans, all of whom must successfully co-operate to the perfection of each individual piece. The failure of any of these will mar, and perhaps destroy, the work of all the rest.

GLAZING: THE DIPPING TUBS.

Within the general and all-embracing term "pottery" the variety of objects generally included is infinite—from the red brick to the encaustic tile, from the garden pot to the china cup. The factories making the heavier and cheaper class of goods are, as a rule, located in the district where the clay is found. To form some conception of their extent and character many outlying places must be visited.

As a rule, the red bricks and roofing tiles, as well as the garden pots and such-like, are made from alluvial clays. These are so widely distributed that the industry can be said to belong to no particular neighbourhood. The more populous areas naturally attract the largest enterprises, and in these the use of machinery has superseded the primitive hand-making. The latter, by-the-bye, has not changed one whit since the time of Pharaoh and the Israelites, and is still amongst us in the smaller brickfields. One of the chief exceptions is that of Fletton, in Huntingdonshire, where millions of bricks are finished each week, being stamped out of the semi-dry clay, ground and delivered automatically by a continuous machine.

Two distinct classes of clay are available for the potter in addition to the alluvial clays. One consists of clay deposits formed from disintegrated granite. The other embraces clays, more or less refractory, found beneath the coal measures. The chief localities producing the former are Devonshire and Dorsetshire, and in the neighbourhood of Poole and Teignmouth a number of potteries and tile-works produce sanitary drain-pipes, spirit-bottles, and, indeed, almost all classes of coarse ware, such as terra-cotta, paving tiles, sinks, gulleys, and mangers.

The proximity to the seaboard, however, affords a ready means of carriage for this clay to other distant parts where either coal or customers are plentiful. Hence large potteries dependent on such material have been established at Lambeth, at Glasgow, at Bristol, at Newcastle-on-Tyne, and also near Liverpool.

All these manufacture vitreous wares, such as are used for acids, dyes, chemicals, spirits, ales, preserves, oils, etc., as well as for the electrical insulators and conduits. This branch of the industry has been developed with much energy, and the initiative is largely due to the persevering enterprise of the late Sir Henry Doulton, who persistently encouraged by every means the use of vitreous stoneware for domestic and manufacturing purposes.

In the undertakings dependent upon the clays adjacent to the coal measures an extraordinary activity has sprung up during the last thirty years. The introduction of white-glazed bricks, which are produced from semi-refractory fire-clays, has afforded an admirable facing for subways and areas where

reflected light is needed, and a continually increasing demand is the result. A further outlet for this material has been found in the manufacture of white-glazed sinks and lavatory basins, and large numbers of operatives are occupied in the production. Among the chief centres are Leeds, Halifax, Stourbridge, Swadlincote, Bolton, Kilmarnock, and North Staffordshire, in all of which districts extensive coalfields occur.

DECORATING (HAND PAINTING).

Two other branches of the industry yet remain unnoticed, viz. drain-pipes and wall-tiles. The former are made in almost all the centres above named, and the quantity produced is enormous. From 300 to 400 miles per week are turned out, and the increasing demand of sanitation seems always able to cope with the supply. So perfectly have the machines been designed that pipes of 36 inches diameter, each weighing nearly half a ton, can now be obtained without a flaw.

For many years past Great Britain has supplied not only her own demands for ware, but those of other nations. America and the Colonies, as well as many Continental markets, have readily purchased her clay products in every form.

WILTON P. RIX.

FINISHED GOODS IN THE WAREHOUSE, BRITANNIA POTTERY, GLASGOW.

FIVE MILES OF PEA TRIALS (CARTER'S).

WORK ON A SEED FARM.

GROWING PLANTS FOR SEEDS.

THE seeds are sown, and the harvest of flowers is reaped. Here, in a few words, is the life-history of many thousands of plants as far as the general cultivator is concerned. It is nothing to him from where and when the seeds which bring forth his cherished plants have come. He looks to his seed merchant or his nurseryman to supply him with good seeds for the good money with which he pays. Of the infinite care, the peculiar—one might almost say the intuitive—skill, and the hours of weary labour which must be given before the seeds he buys so cheaply can be garnered he knows little or nothing. And yet the growth of plants for the production of seed alone in our glass-houses, our gardens, and our fields is one of the important industries of our tight little island. Its value is represented by hundreds of thousands of pounds; it gives remunerative employment to thousands of men; while the perfect products—the plants from the seeds—bring benefit and pleasure to millions of people of all classes and of all creeds.

CUTTING CABBAGES FOR SEEDING PURPOSES (WEBB'S).

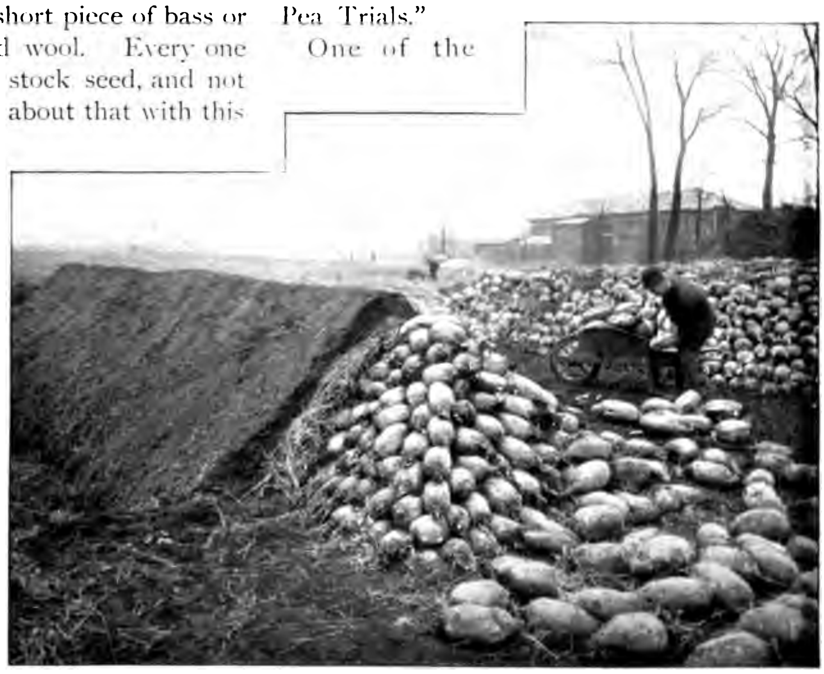
All the seeds distributed even by such wholesale houses as Hurst and Son, Cooper, Taber and Company, Limited, Watkins and Simpson, Wrench, and such retail firms as Messrs. Sutton, Carter, Veitch, Webb, and others, though they have vast areas of land, are not actually grown by them. As such a course would be impossible, they have certain seed growers who cultivate exclusively for them, and to whom "stock" seeds are supplied. These represent the finest possible selections that can be saved. Supposing a man be growing tomatoes for Messrs. Carter from stock seed, he advises the firm when the plants are in full crop, and a skilled representative visits the farm. He is a man of ripe knowledge, and every plant is submitted to a

SELECTING TURNIP ROOTS FOR SEED (WEBB'S).

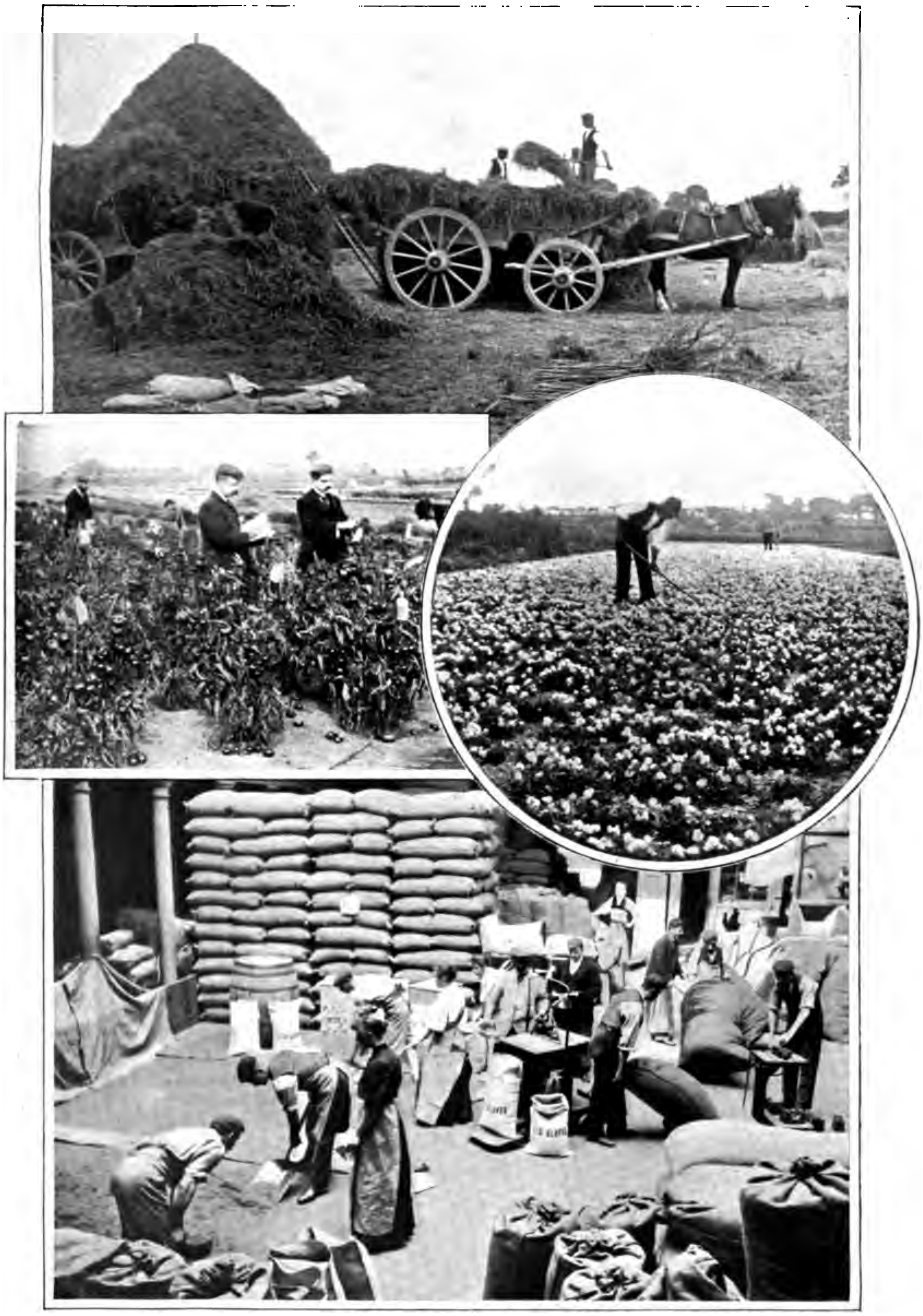
searching examination, and should one show the slightest signs of deterioration—if it falls short of the inspector's ideal—it is immediately pulled up and thrown away; the reputable firm cannot afford to save seed from such as these. But the expert goes a step further than this; for each perfect fruit—and in a tomato this will mean colour, form, depth of flesh, and a good truss—is specially marked with a short piece of bass or of conspicuously coloured wool. Every one thus distinguished is for stock seed, and not for sale. Thus it comes about that with this care each season the variety never falls below a certain clearly defined standard; on the contrary, there is frequently a perceptible advance. As it is with tomatoes so it is with all kinds of flowers and vegetables, as well as all kinds of farm crops. There is ever that strenuous searching for the ideal which spells excellent stock seeds and means the maintenance of the reputation of the house.

One might think that this expensive process of examination would satisfy the most exacting seed merchant, but such is by no means the case. He must ascertain the vegetative power of every kind and variety of seed that enters his warehouse. For this purpose a sample is taken of each, and the packet is marked with the name of the variety and the source whence the bulk was obtained. These are then entered in a book in which all the particulars are repeated and a column is left blank. A certain number of seeds are sown in pots or in the open ground, or on sheets of blotting paper kept consistently moist, and as they germinate the exact number of seedlings is counted and entered in the column that has been reserved in the trial book. Here, again, a certain standard is essential, or the seeds are never sold. Then, if a customer writes to complain that such and such a packet of seeds failed to give satisfaction in germinating, reference is made to the book, and the seed merchant sees at a glance exactly how many per hundred vegetated under trial. This, of course, tends to the satisfaction of both seller and buyer. Some idea of the magnitude of the outdoor trials is given in our illustration portraying "Five Miles of Pea Trials."

One of the



STACKING MANGOLDS (SUTTON'S).



I. A STACK OF CARTER'S DELICATESSE RADISH. II. GROWING TOMATOES FOR SEED.
III. A FIELD OF DWARF SWEET PEAS. IV. BAGGING CLOVER SEED.

(From photographs by kind permission of Messrs. J. Carter & Co.)

important operations in growing crops for seeds is the removal of what are termed "rogues," *i.e.* plants of a different variety from that which is supposed to be under culture. Many of these are reversions to inferior varieties, but some are decided improvements. The poor ones are withdrawn and thrown to the rubbish heap, and the very occasional promising plant has a distinguishing mark placed upon it for special saving, as has been previously described. The "rogueing" is not the work of skill that saving plants for stock seeds is, and it is done by ordinary workers, who have but to grasp the features of the variety and then remove all others. It, of course, requires care, and is not the most pleasant of work, as it is done in the summer, sometimes under a broiling sun, which strikes down upon the back of the worker without the least obstruction.

One of the aids to the production of new varieties of flowers and vegetables is shown in the illustration of one of Messrs. Suttons' houses of Chinese Primulas. There may be seen two men fertilising the flowers. In this case the flowers are being inoculated with the pollen from another flower of the same variety, and the object is to insure a good "set" of seed. Fertilisation on outdoor plants is conducted through the natural agencies of wind and insects, amongst the latter being bees, who in this respect render immense service. Supposing Messrs. Sutton desired, as they have many times, to raise a new variety, they would fertilise any one variety with the pollen from some dissimilar variety; thus, the pollen of a red primula may be applied to the flower of a white one, and so on. The result may be flowers that are distinct from their parents, or, though similar in colour, superior in other respects. In such cases they would be saved; but if showing no advance they would be destroyed.

The arts of hybridisation and cross-fertilisation, artificially conducted, are not the only things which bring us novelties for our gardens. A plant may "sport," *i.e.* throw up one flower that differs entirely from every other on the same plant. If this is good, every endeavour is made to "fix" it, and a new variety is secured. Chrysanthemums are amongst the "sportive" plants, and it is a curious fact in relation to them that the same variety may "sport" in two or three gardens hundreds of miles apart, and the fresh flower will be similar in each instance. Observation, too, has given us many an excellent improvement. For example, when Messrs. Carter bought the stock of "Telegraph" Pea from a Mr. Culverwell, they sent the seeds to their Essex farms to be grown. The man in charge was keenly observant, and, seeing round and wrinkled seeds, he separated them carefully. The result was a distinct variety, which was named "Telephone." The well-known green pea "Duke of Albany" also came from "Telegraph." A gardener named Abbot noticed one pod on a row of "Telegraph" that was much finer than any other, and he saved it. There were eight seeds, and every one gave a different variety, but one only was good. This was tended with special care, was selected and re-selected, until "Duke of Albany" was secured.

A FIELD OF ONIONS GROWING FOR SEED (CARTER'S).

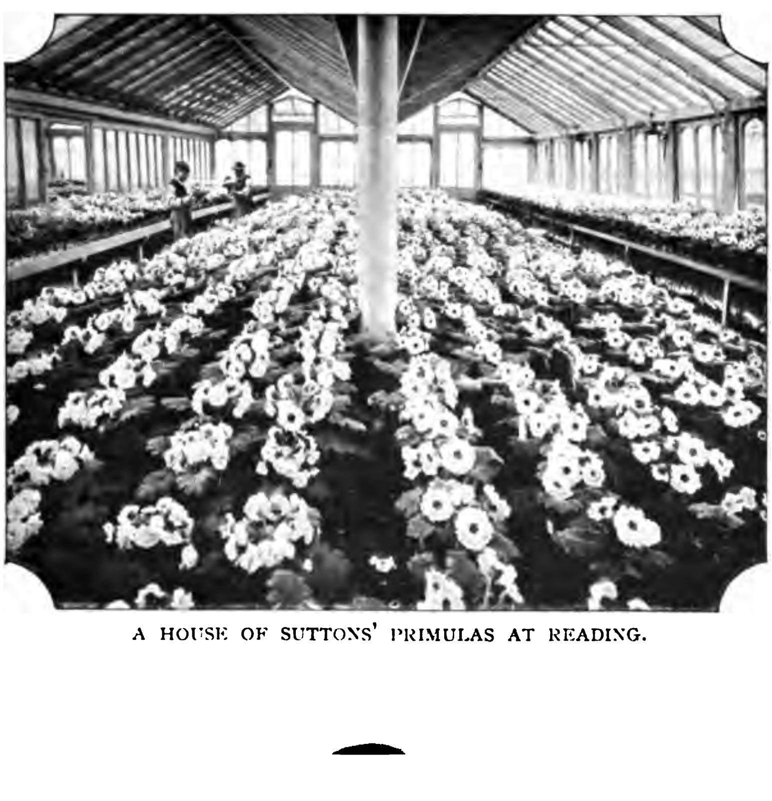
Novelties, even though of great beauty, do not always bring riches to their raiser, as is proved by the fact that the man who gave us the beautiful and indispensable Golden Feather only received two Geraniums for the stock of it. This, of course, was many years ago, and a man would receive much better treatment nowadays. The coming of Golden Feather was one of the mysteries of plant life, for

none could say whither it came. The first plant came up in a pot containing a Geranium, and the grower, noticing the rich colour and the elegantly cut foliage, looked after it; and our present-day favourite resulted.

WOMEN HAND-PICKING PEAS (WEBB'S).

Assuming that the seeds have been carefully ripened and harvested, the next operation will be cleaning, which is done in large warehouses. The details with different kinds vary considerably, but the broad principle — to remove chaff and light seeds—is the same. Big stocks of seeds are cleaned by machinery operating fans, which blow out defective seeds and husks, and leave the clean, sound product. With a seed like Begonia, an ounce of which may be worth £25 or even more, delicate handling is necessary, and it is fanned by hand labour; a skilful worker being able to throw out bad stuff without wasting one sound seed. This method is adopted with many choice seeds. A third system is cleansing by hand sifting. Hair sieves or riddles are employed, and a rotatory action is maintained. This will bring the chaff and light seeds into a little heap in the middle, whence they are carefully removed; the sifting is persisted in until not a single bad seed can be brought to the surface.

With Peas and Beans hand picking becomes a necessity, as there is no machine which will clear out every specked seed. Some of these are as heavy as the good seed, and many of them have equal germinating power; but in appearance they spoil the sample, and must therefore be removed. This is done by women, as shown in one of our illustrations. The benches have holes in the centre in front, beneath which sacks are attached. The peas are drawn towards the operator, the bad ones removed, and the good ones passed down into the sack. The work is done very rapidly by experienced pickers,



A HOUSE OF SUTTONS' PRIMULAS AT READING.

who are paid so much a bushel of cleaned seeds. An overseer examines every sack, and if badly picked it has to be done again. The seeds properly cleaned, whatever they may be, are ready for weighing and bagging. The packeting for retail distribution is done by machinery, and by measures holding given amounts. This operation, like pea picking, is commonly done by girls and women. The packets usually have a brief description of the plant upon them, and in many cases excellent cultural directions also—in fact, everything possible that will assist the cultivator is done.

SELECTING MARROWS FOR SEED PURPOSES (CARTER'S).

The area of land required by seed growers is enormous, it being exceedingly difficult—if not impossible—to keep the stocks of seeds true where different varieties of the same kind are grown in adjacent plots. For example, if a bed of long Carrots adjoin a bed of short ones, the pollen from the flowers of one would be carried to the flowers of the other by insects, and this crossing would result in a mixed, and therefore an unsatisfactory, stock. It is the same with other plants; and to obviate danger from this source the plots are distributed as widely as possible over the land, so that the pollen-carrying insect will pass, say, from a carrot to a cabbage, and no crossing will ensue.

The aspirant to seed saving may seek some standards of excellence by the close adherence to which he may be enabled to save seeds of conspicuous merit. Mere size does not always constitute excellence; there must also be points that are learned only by experience. Let the grower of plants, whether for home use or for seeds, work to a high ideal, never resting content, and he will be treading in the footsteps of the firms named in this article, who raise plants from seeds to produce seeds, the products always to be equal, and where possible superior, to the originals.

HORACE J. WRIGHT.

SELECTING CORN FOR SEED (WEBB'S).

THE STRAW HAT TRADE.

A DISTINCTIVE ENGLISH INDUSTRY.

AMONGST the essentially British handicrafts which have flourished at various periods a prominent position is claimed by the straw trade. It is one of the most beautiful of modern industries, for not only are the materials employed of necessity elegant, but it calls for the exercise of artistic taste and of originality in design. So far as the department of feminine headgear is concerned, it is readily understood that the business is primarily dependent upon the vagaries of Dame Fashion, whose whims and fancies are as changeable as the hues of the chameleon. This fact renders it incumbent upon those engaged in the straw trade to be at once enterprising and resourceful; and that the English manufacturers keep abreast with the times is evidenced by the fact that, in spite of the keenest foreign competition, the home producers of hats and bonnets of straw and other fancy materials succeed in retaining the trade in those parts of Bedfordshire and Hertfordshire where it originated. A popular misconception regarding the straw trade is that the plait utilised in the manufacture is made in the district. That was certainly the case in former years; but the mutations of time have changed all that. To-day the special work of the straw traders of Luton, St. Albans, and Dunstable is to make up the plait into those exquisite creations so dear to the heart of the feminine portion of the community. Many years ago Dunstable was the seat of the industry; to-day Luton has left its neighbour far in the rear in the race for fame and fortune, and has become the metropolis of the straw trade, whilst St. Albans has also beaten its smaller competitor over the county border.

Photo: Cassell & Co., Ltd.

STRAW PLAIT ROOM (MESSRS. A. J. HUCKLESBY AND CO.).

It was at Dunstable, however, that the first straw bonnet was produced. This was made of whole straw, the method of splitting the straws not having yet been discovered, and it is thought to have been of the "coal-scuttle" shape, a type that continued in vogue for a long time. Then means were devised for splitting the straws, and to this invention may be attributed the success which afterwards attended the manufacture of straw plait in England. Its introduction brought about quite a revolution, and it was not long before bonnets composed of the split straws had succeeded in displacing the whole-straw Dunstable creation from favour. Later on Leghorn hats began to be imported, and these became so popular that the home manufacturers were alarmed. After a time a new kind of plait was invented, from which was made a Tuscan grass bonnet that was regarded as superior to the Leghorns, and satisfied the fickle devotees of Fashion for

Photo: Cassell & Co., Ltd.
MACHINING STRAW HATS (MESSRS. J. A. AND F. HIGGINS).

a considerable time. The competition experienced from the Continent failed to produce any appreciable effect, and it was not until late in the sixties that Chinese plait began to be extensively utilised. The turns of Fortune's wheel have since then brought about quite a different state of affairs, so much so that the foreign fabrications have almost wholly ousted the British manufactures. The imports of Canton plait rapidly swelled in volume, and by-and-by fancy plaits were poured in from Switzerland, Germany, and Italy, while of late years Japan has become a formidable competitor to these other countries.

The Straw Hat trade is a season trade—that is to say, it is only in full swing during certain months of the year. The busy time is from February until about Whitsuntide, so that during the summer months there is considerable slackness in Luton, which is the chief seat of the industry. A visitor to the town on any evening during the busy period would be able to witness a scene which is unique. The boxes in which the goods have been packed during the day for despatch to London and elsewhere are loaded on the railway companies' drays, and an imposing procession sets out for the railway stations from the centre of the town, for it is from the principal thoroughfare (George Street) and the contiguous streets that the bulk of the output is despatched. The spectacle of the lorries, with their ten feet high loads of boxes, is an extremely interesting one, and so busy are the drays in collecting that special police arrangements have to be made for regulating the traffic. It is at six that the journey to the railway stations begins, and the extent of this evening traffic may be imagined when it is stated that on one night the number of

Photo: Cassell & Co., Ltd.
BLOCKING STRAW HATS (MESSRS. W. WALSH AND SON).

boxes despatched from one of the two railway stations was about a thousand.

Beyond the presence of these boxes in the streets, and of bales and bunches of plait in some of the warehouses, there is little or nothing to indicate to the stranger the magnitude of the trade that is carried on, though at the height of the season the factories are brilliantly illuminated in the evening, and the whirr of the sewing machine is a familiar sound. Nowadays a large part of the work of manufacture is carried on in small factories away from the centre of the town, the finished goods being sold by the small makers to the merchants in the principal thoroughfares. A peep into one of the showrooms would delight the average woman. Here are rows and piles of hats of all shapes and sizes, and of infinite variety in regard to both colour and material. They are displayed temptingly for the inspection of the buyers who represent the wholesale houses in London, the provinces, and abroad, who regularly visit the town. For the most part the hats are untrimmed, that being left to the milliners; but some firms have during the last few years gone into the trimmed hat trade, and have been very successful.

Photo: Cassell & Co., Ltd.

IN A STRAW HAT SHOW-ROOM (MR. GEO. WARREN'S).

To enter into a lengthy technical description of the manufacture of headgear would not come within the scope of this article. A brief sketch may, however, be acceptable. The plait having been procured—for we are now dealing with the evolution of a straw hat, pure and simple—it is sewn into the required shape by machinists. The sewing machines used for the purpose are specially adapted for use upon straw, and considerable skill and enterprise have been expended in this direction. The machinists, who are generally females, are accommodated in spacious rooms, and the scene presented by a score or so of the machines being rapidly driven is a striking one. Until quite recently the machines were set in motion by the feet of the operators; but now that electric power is available some of the manufacturers have installed electric motors.

When the process of sewing has been completed, the shapes are stiffened with gelatine, and "blocked" upon blocks of wood or composition, a process which is performed by machinery, though hand-blocking is still resorted to in some instances. Then the hat, when thoroughly dry, is handed over to the finisher, whose business it is to fit it with lining, tip, and leather, and trimmed with ribbon. It is subsequently ticketed, invoiced, and packed, and so is made ready for its despatch. The goods from Luton find their way to all parts of the world, the shipping trade being a very important department. Hostile tariffs have, however, exerted an unwelcome influence in several of the European countries; indeed, the trade with France, which was formerly a flourishing one, has to all intents and purposes died away in consequence of this.

The process of manufacture of fancy hats is necessarily somewhat different from that of straws. The fabrics employed in these do not lend themselves so readily to the operations of stiffening and blocking. The ajour and crinoline varieties form instances of this. It would be impossible, for example, to deal with a horsehair material in the same way as the firmer straw plait, and accordingly a different means of preparation is resorted to. The hand-sewer is employed, and when something like the required shape is obtained the hat is deftly pulled and twisted into the desired design. Many of these fancy hats are moulded upon wire frames, a device

which affords material assistance to the operator, and quite a new industry has been created in the preparation of these adjuncts. It will be understood, too, that there is ample room in the ordinary way for the manufacturer's material merchant, who provides the various articles used in the formation of a hat, from gelatine and cotton to linings, leathers, and bands.

Before passing away from the subject of manufacture, let it be said that when sewing machines were first employed, and the production of hats began to increase, the hand-sewers prophesied ruin and disaster. Their prognostications were, fortunately for Luton and the district, proved to be unfounded, and from the time of the introduction of machinery into the work the story of the town has been one of continuous progress; so much so that, whereas in the middle of last century the population stood at only a few thousands, there are to-day close upon 40,000 residents. These are not wholly dependent upon the straw trade, however, for there are various other industries, and the number of these is constantly being increased in consequence of the zeal and enterprise of the leading public men.

So far as St. Albans is concerned, it has to be said that the Straw Hat trade was taken up there something like forty years ago and that it has flourished exceedingly. At the outset the manufacturers made ladies' hats as well as those for men and boys; but as the years passed the ladies' hat trade was transferred to Luton and Dunstable, and St. Albans devoted itself more especially to straw gear for the mere males. It is argued by the merchants in the cathedral city that the St. Albans trade is more reliable and remunerative than that of Luton, though that of Luton is more extensive, and the reason assigned is that masculine hats are not so much affected by fashion as are those for ladies. The St. Albans manufacturers, by the way, have not quite a monopoly in the department of men's and boys' hats, for at both Luton and Dunstable considerable attention has been devoted to this branch during the last few years, when the hot summers have led to the donning of straw hats by all sorts and conditions of men, and this attention has brought a large increase of trade. There is much force in the suggestion as to the trade of Luton being dependent upon the smile or the frown of Fashion. This fact, coupled with the proximity of the town to London, does not permit of anything being "behind the fair."

Photo: Cassell & Co., Ltd.

GEORGE STREET, LUTON: CASES OF GOODS WAITING FOR COLLECTION.

Any review of the straw trade which omitted allusion to the local bleaching and dyeing industry would be incomplete. This has been brought to a high state of perfection

Photo: Cassell & Co., Ltd.

"EMPTIES" IN THE GREAT NORTHERN RAILWAY GOODS YARD, LUTON.

in Luton and district, and the English dyers of plait can challenge the competition of the world. Year by year the principal firms seem to improve in regard to the exquisite tints which they succeed in procuring. Large quantities of straw plait are annually sent to Luton from abroad to be dyed, and are re-exported to America, Canada, Australia, Germany, France and elsewhere. In regard to the fashions in hats it ought to be said that though there has been a run at times on the fancy varieties, the sailor shape has always been popular with the ladies. In the matter of patterns and combinations of materials there has been an entire change since the time when the Straw Hat and Bonnet trade came into prominence. Formerly a manufacturer could go on almost indefinitely making up hats from a specific shape; nowadays it is a common thing for orders to be received by the merchants for single hats, this necessarily rendering it incumbent upon the makers to be constantly inventing new patterns. Originality is as much an essential in the Straw Hat trade as it is in the fabrication of the plait wherewith to make the hats, and it is to the skilful designer that the bulk of the profits go. The straw trade is one that affords ample scope for enterprise, and that those engaged in it in the past have been pushful is proved by the fact that very large fortunes have been made by the principal traders.

W. H. McNamara.

BUTE STREET, LUTON. Photo: Cassell & Co., Ltd.

THE TRAVELLING POST OFFICE. *Photo: Cassell & Co., Ltd.*

HIS MAJESTY'S MAILS.

A SIMPLE statement in figures will often give to a reader a better idea of the extent of a business undertaking than pages of descriptive writing. But when the figures run into billions the limits of the human understanding are almost reached, and the average man experiences only a sense of bewilderment when he sees the numbers in print.

The billions of packets, of course, imply a huge machinery which is at work day and night throughout the British Isles, and a staff of workers with whom the most minute division of labour is a necessity, in order to produce that smooth and rapid movement on which the whole business depends. The counter clerk who sells the penny stamp, and the postman who delivers the letter, are the two officials who are known best to the public, but the different officers who conduct the operations which come between the transactions mentioned are almost unknown outside the walls of their own offices. In the London district alone there are 5,414 persons employed in the sorting of postal packets, and there are 658 persons engaged in superintending this particular work. The postmen of London number 8,776, and there is a miscellaneous postal force, including mail officers, messengers, etc., of 1,753 persons. These are all employed in the work of the delivery and the despatch of "His Majesty's Mails" in London.

A very large proportion of these officials are at work at the head office, St. Martin's-le-Grand, or at the sorting offices, Mount Pleasant, and here is to be seen on a large scale the same routine which goes on at every district branch and head office in the United Kingdom.

What becomes of a letter after it has disappeared down the capacious mouth which swallows thousands of postal packets daily at St. Martin's-le-Grand? The first process is very simple. The letters are taken from the collecting box, and are turned out just as they are on to what is called the "facing" table. Here the letters

are "faced": that is to say, they are placed in such a position that the postage label is in the right-hand corner, and is ready for the stamper. At this table the first attempt to divide the correspondence is made, and large letters, packets, and newspapers are weeded out for separate treatment. Then the letters are removed to the stamping tables, where they are impressed by machinery with a stamp indicating the time and place of posting, and the postage stamp is cancelled. New electric motor stamping machines are now used for this purpose. The stamped letters are passed on to the sorting tables, where they are divided into sections representing the great railway lines of the kingdom—London, Scotland, Ireland, and several large provincial towns receiving special treatment. A survival of old mail-coach days exists in the name which is given to the various sections into which letters are sorted. They are called "roads," and on the sorting frames will be found inscriptions such as Chester Road, Carlisle Road, or Worcester Road.

Photo: W. G. W. Sandison, Shetland.

THE MOST NORTHERLY POST OFFICE IN THE KINGDOM: HAROLDWICK SUB-OFFICE AND POSTMAN.

As an object lesson in the work of the Post Office, let us trace the progress of a letter from London to the Muckle-Flagga Lighthouse, on the island named Muckle-Flagga, to the north of the island of Unst, Shetland, the most northerly point in the British Isles. We post our letter at St. Martin's-le-Grand on a Sunday night at six p.m., and, given favourable conditions of weather, it will be delivered at the Muckle-Flagga Lighthouse on Thursday morning.

The letter is dropped into the box, and goes through the various processes we have described: is sorted into the Scotch division; is sub-sorted into a pigeon-hole, and afterwards into a bundle labelled "Aberdeen forward." The bundle is dropped into a bag inscribed with the words "London to Aberdeen," and one of the familiar red vans conveys the bag to Euston. The bag is handed over to the sorters in charge of the two Post Office sorting vehicles, which are run in the down Special Mail Train leaving Euston for the North at 8.30 p.m. On this train is a mail carriage that runs direct to Aberdeen, in which our letter is placed, and Aberdeen is reached at 7.35 a.m. on Monday. So far the course of the letter has been simple and rapid, the remaining stages will show how much considerations of weather still affect postal operations in many parts of the country, and how dependent the Post Office is sometimes on quite primitive means of locomotion.

Photo: W. Childs, Leeds.

A GREAT PROVINCIAL POST OFFICE (LEEDS).

The bag containing the Shetland letter on arrival at Aberdeen is quickly conveyed to the Aberdeen Post Office, where it is opened, and the letters are again sub-divided. The letter for Muckle-Flagga finds its way into a pigeon-hole labelled "Lerwick," and an experienced sorter then checks all the packets for the Shetland Isles very carefully,

Photo: Cassell & Co., Ltd.

GETTING READY FOR THE MAIL.

Photo: By permission of the Royal National Mission to Deep Sea Fishermen.

DELIVERING THE MAILS ON BOARD A FISHING SMACK

as, in consequence of the remoteness of the group, serious delay would ensue if any were mis-sent. Then they are tied in separate bundles, and are placed in not an ordinary mail bag but a strong water-proof sack, labelled "Aberdeen to Lerwick," and at 1.45 the same day (Monday) the bag is conveyed to the mail steamer, which starts at 2 p.m. for Scalloway, on the west side of Shetland, where it arrives about 2 p.m. on Tuesday. The mails are removed from the vessel, and placed on a mail coach, for conveyance to Lerwick, on the east side of the island, which at this point is six miles wide. Our bag is opened at Lerwick, and once more the Shetland letter undergoes the process of sub-sorting. It is stamped, and placed in another bag, labelled "Lerwick to Haroldswick," in the island of Unst. The bag is conveyed by the Lerwick and Mossbank mail car, leaving Lerwick at 9.15 p.m. Tuesday. The Shetland Isles are seventy-three miles from north to south, and this stage means a long drive with a break of a few hours at Voe. Mossbank, which is on Yell Sound, the dangerous channel that separates the island of Yell from the Shetland mainland, is reached at 7.30 a.m. on Wednesday. Here the bag for Haroldswick is put on a ferry boat, which starts at 8 a.m., and is due to reach the other side in an hour, the distance being three miles. But the tide in Yell Sound has a speed of nine miles an hour, and, in a gale of wind, is the terror of seamen.

Ulsta is the landing-place on the other side, and we are now in the island of Yell. A mail car takes our letter five and a half miles to Bunavoe, and another car from there to Cullivoe, twenty miles further on, and the letter is opposite the island of Unst at 3 p.m. on Wednesday. The ferryman who plies between the islands of Yell and Unst, across a channel one mile in width, takes charge of the letter, and he should arrive at Tranavoe, in Unst, about 3.30 p.m. There a mail car awaits to carry the letter eleven and a half miles across the island of Unst, and it arrives at Haroldswick at 6.30 p.m. the same day.

And the last stage of the letter arrives when the following morning a foot postman starts for the shore station of the Muckle-Flagga Lighthouse, where he delivers the packet. But here it may lie for weeks before the people on the shore can communicate with those in the lighthouse. The British Isles in these northern latitudes end in grand and dangerous rocks, and it is upon one of these, rising to a height of two hundred feet, that the Muckle-Flagga Lighthouse is erected, the real Ultima Thule of North Britain.

In order to observe more closely another department of Post Office work, let us get back to London. Travelling post offices, in which postal work is conducted in trains which are in motion, run every night from Euston Square to Aberdeen and Holyhead, from Paddington to Penzance, from Waterloo to Southampton and Dorchester, from Bristol to Newcastle, and in Ireland between Dublin and Belfast and Dublin and Cork. At different points on the route of each train are erected standards and nets for the

despatch and receipt of mails. Bags are dropped, and others are collected, as the mail train rushes along. The bag to be forwarded is suspended from a projecting arm at the station; is so knocked off by a projection from the train in full motion as to fall into a net which is attached to the mail carriage, and is for the moment stretched out to receive it; while at the same time the bag to be left behind, being hung out from the mail carriage, is in like manner so struck off as to be caught in a net fixed at the station—the whole of the complex movement being so instantaneous that the eye cannot follow it.

Inside the travelling post office the sorting of letters goes on merrily: the car is fitted up in all respects like an ordinary sorting office. The cost of the conveyance of the mails by railway amounts to more than one and a-half million pounds annually.

The letters posted in London for large provincial towns, such as Leeds, Liverpool, or Bristol, are despatched in bags direct to these towns, where the postal organisation follows more or less the lines of the London head office. Some of the new provincial head offices are among the finest buildings in the kingdom. Leeds, in particular, possesses a magnificent post office. It is the Central Exchange for the trunk telephone wires, and it has, therefore, been

Photo: C. Knight, Aldershot.

THE SOLDIERS' POST BAG.

necessary to make special provision for this department of post office business. Electricity, indeed, plays a most important part over the whole building, and the only portion of the premises to which there is a supply of gas is the kitchen, where it is used for cooking purposes. Even in the heating of the wax used in sealing the mail bags electricity is brought into use. The wax is placed in small copper pans which rest on electrical hot plates.

Photo: Cassell & Co., Ltd.

A RURAL POSTMAN.

The undelivered postal packet is always a source of great distress to the Postmaster-General when he makes his annual report, and it would seem that either the British public is growing more careless or its faith in the omniscience of the Post Office is increasing. Take, for example, the case of Leeds, where in one year there were 31,990 letters which could neither be delivered to the addressees nor returned to the senders. In other large towns the figures are not less startling.

Property of the value of £680,000 was found in one year in letters opened in the Returned Letter Offices in the United Kingdom. Strangest of all phenomena in the statistics of human frailty is the fact that 345,690 packets have been posted during a period of twelve months without an address, and they actually contained cash and paper money to the value of nearly £7,500.

The statistics of the post office in a large town like Liverpool are interesting. The population is about 700,000, and in one ordinary week there were delivered in the district 1,724,938 letters; 716 postmen are employed in the district; and there are 447 town letter-boxes. Liverpool is an exceptionally busy post office centre, because of the foreign mails which are made up here. Those for West Africa have to be enclosed in waterproof bags, as at some places they are thrown overboard, and are washed ashore through the surf.

The chief differences between London and a provincial town as far as the post office is concerned consist in the cross posts and rural district systems which are in existence in the big country offices. In the Liverpool district there are five district and twelve sub-district offices, at which the postmen not only deliver and collect but stamp and primarily sort the letters they collect. A country postman in these districts is a man from whom much is expected.

Before the year 1897 there were hundreds of places which had never boasted of a free delivery of letters. The inhabitants of many isolated rural districts had to make their own arrangements for getting their letters from the nearest town. But this is now altered, and the extension of rural posts is practically complete. The rural post office is in miniature what the big town office is, with the important exception that the sorting is here reduced to a minimum.

This sketch of the work of the Post Office in the British Isles would be incomplete without some reference to the mail routes to the Continent. By far the greater number of Continental mails go *viâ* Dover and Calais, and by this route goes every week, on Friday

evenings, the Indian mail. The carriage of the mails by the packet service costs the Government nearly £25,000 a year, and in cases of delay the Post Office has the right to fine the contracting company £5 for twenty minutes, and £5 for every additional fifteen minutes. The London to Dover mail train has a sorting carriage attached every night, but on Fridays the number of bags carried is greatly in excess of other days. The bags of the Indian mail not infrequently number over 1,800, each one of which weighs on an average 50 lb. They do not all come down to Dover by the same train or cross by the same boat, but they unite at Calais, and cross the Continent to Brindisi in charge of a man from the London office.

The total number of persons employed in the Post Office in the United Kingdom is over 173,000, of whom about 35,000 are women. Of these, by far the larger portion deal with his Majesty's mails, either solely or in addition to telegraph, money order, and savings bank duties. The parcel post comes, of course, under our title, but it calls for no special treatment, as in so many ways the parcel is governed by the same conditions as the letter, and we have always included it in the term "postal packet." The number of parcels conveyed by the Post Office in one year, according to the most recent return, is 81,017,000, and a large number of these are carried on the back of the long-suffering postman; yet there are critics of the Post Office who have complained of the gait of the average postman; they have asserted that he does not carry himself well, that he seems depressed, and takes a cynical view of things. Both mentally and physically he seems overburdened with the responsibility and the weight of "His Majesty's Mails."

EDWARD BENNETT.

Photo: Cassell & Co., Ltd.

SHIPPING THE MAILS AT DOVER.

HOW GAS IS MADE.

UNPROMISING though it may appear, the production of gas from coal presents some interesting and, indeed, weirdly picturesque features.

The essential principle is, of course, the subjection of certain classes of coal to great heat in a closed vessel, when a part of the substance passes off as gas, and can be collected to burn with a luminous flame at the end of a pipe. Imagine, therefore, long lines of small, black, round doors, one line set above another, in a long, black wall, having black pipes rising upward from near the doors, to a long black box at the top of the wall. The wide roof above is dark and dingy, and heaps of coal opposite the round doors add to the prevailing hue. From this big black cavern the magicians of manufacturers produce the brilliant artificial light which is to illuminate so many hours of darkness.

Suddenly a group of men come on duty. One of them swings open a door, and flames burst wildly forth, lighting up the dingy building with a weird and lurid glare; but the three men—for there are three to a gang or group who work together here—speedily rake out the fiery hot mass from within, and it falls through an opening in the floor—protected by a sheet of iron—to the shed below, where other men are waiting to quench it with water.

Hissing and steaming, the stuff quickly cools, and is now known as coke. The small will be sifted from the large, the small cinder being known as "breeze." Coke is the coal from which the gas has been "distilled" or extracted; the door whence it came is the entrance to the retort; while the building is known as the Retort House, in which the coal gas is actually produced.

Having cleared out all the coke, the men proceed to re-charge the retort. If experienced and well up to their duty, they work with a swing and a rhythm of action which is good to see. Their object, of course, is to get the door of that fiery furnace closed as soon as possible.

DRAWING THE RETORTS.

While one man, with a regular sway of his body and a swing of his arms, throws one shovelful after another of coal into the white-hot opening, his comrades are filling the scoop. This instrument is like a long pipe cut lengthwise midway in two, and is fitted with a long cross-handle at the end.

When it is full the leader of the group gives the word; each of the three men throws a couple of shovelfuls to the end of the retort, the leader grasps the cross-handle, his companions lift the scoop in the middle by means of an iron rod placed underneath, and it is then run smartly into the retort over the


QUENCHING THE COKE.

Photo: Cassell & Co., Ltd.

rod, turned briskly, and pulled out empty with a flourish! The whole process is so deftly and systematically performed that probably about the same amount of coal is shot into the retort on each occasion. The performance is gone through twice for each retort, and by this method the vessels are charged according to their capacity for yielding the best results.

The work is arduous in the great heat, and in large establishments a group of men are allowed a spell of rest at the lapse of each half-hour, their shift of work occupying about eight hours before they leave. But, again, in some works machines running on rails in front of the lines of doors are used to rake out the glowing coke and re-charge with fresh coal. Six hours is about the length of time which the coal is allowed to remain in the retorts to give off its gas. The retorts are usually made of the most stubborn fireclay, and are three inches or so in thickness. They are built together very solidly over furnaces, and are almost continuously kept white-hot. The heat of the furnaces is intense, being considerably over 2,000 degrees Fahr. The temperature may be tested in an interesting manner by placing a piece of platinum in the furnace and, when hot, plunging it immediately into water; the rise in temperature of the water is then taken, and an approximate estimate formed of the heat in the furnace.

But we must follow the adventures of the gas. It rises from the heated coal in the closed retort, and escapes through the pipes to the large black box above, which contains tar water, and is called the hydraulic main. The pipes dip into the water, and by this arrangement the gas is prevented from returning to the retort. Both tar and water are condensed from the gas, and an overflow pipe leads them down to the tar well.

But the gas itself passes on by a pipe running out from the overflow pipe above the tar well to the condensers. These consist of an arrangement of numerous bent pipes, of which there are several types, kept cold, their frigidity causing more tar to be collected, and from these pipes the tar slowly trickles down to a tar well. After passing through the condensers the gas is still very impure, and has to be washed and scrubbed, and treated with lime to free it from its ammonia and sulphuretted hydrogen.

The "washer" consists essentially of a suitable receptacle containing water, and the gas is simply sent through this water, which dissolves some of its impurities; but in the "scrubber," through which it next passes, it is led up a large pipe or tower filled with deal boards, or with coke having water trickling over it. The washer and scrubber are combined in some manufactories, but in any case the water soon smells strongly of ammonia, and indicates the quantity of that chemical which is being extracted from the gas. Again, by another system of scrubbing, the gas is drawn up through a confined space through which spray is made to descend.

An "exhauster," consisting usually of a pump, which is fixed further on—

generally at the station meter house—draws the gas from the retort through all its mazy windings, a steam-jet injector being also used as exhauster in some works.

After being scrubbed, the gas is made to pass through thick layers of fresh slacked lime in tanks to free it from the evil-smelling sulphuretted hydrogen, bisulphide of carbon, and carbonic acid. Other substances beside lime are sometimes used, such as slightly moist iron oxide, mixed with sawdust, or chaff, to render it porous. The object which must be obtained, however, is to bring up the gas to the Parliamentary standard of purity.

The freedom from sulphuretted hydrogen should be shown, not only by the absence of its very unpleasant odour, but by the fact that ten cubic feet of gas shall not show a stain on lead paper; furthermore, not more than twenty-two grains of sulphur, or four grains of ammonia, must be traceable in a hundred cubic feet.

Passing from the lime tanks, the gas goes to the station meter house, where it is measured, and where the pressure instruments are kept; it is then at last allowed to escape to those immensely large round gas-holders which form the most prominent object of any gasworks. These huge vessels are built over great tanks of water, and in them the gas is stored and kept ready for use.

It is important to notice that the lime purifiers are so constructed that when one part is saturated with impurities, the stream of gas can be directed to a freshly renewed portion, while the impure lime is removed. Indeed, this principle applies throughout, the apparatus being so arranged that some parts can be thrown out of action while other parts are continuing the work.

The ingenuity of chemists and of engineers has enabled manufacturers to increase the volume and enrich the illumination by the use of water-gas and of vapour from mineral oils. The combination of these two products is known as carburetted water-gas, and it may be said without exaggeration that the preparation of this compound now enters very largely into the manufacture of gas. And so long as the product is up to the Parliamentary standard of fifteen or sixteen sperm candles in illuminating power and is free from poisonous

Photo: Cassell & Co., Ltd.

CHARGING RETORTS BY MACHINERY
AT THE GAS LIGHT AND COKE COMPANY'S WORKS, BECTON.

vapour, there is, of course, no fraud in thus producing the illuminant.

More than a hundred years ago Lavoisier showed that hydrogen and carbonic-oxide could be produced by passing steam through fiery hot coke, air being supplied at intervals to maintain the coke in a radiant glow. The hydrogen gas and carbonic-oxide mixed together make the popularly called water-gas. Burnt alone, it is very hot, but its illuminating power is slight; it is, therefore, enriched or "carburetted" by mingling it with gas made from mineral oil. The process consists essentially in passing the water-gas through receptacles called "carburetters" containing intensely hot bricks with the oil sprayed on them. Waste fat is used in some parts of the world as a source of oil gas.

So largely is this process employed that a firm in London has constructed suitable apparatus, for use in Great Britain and other parts of the world, capable altogether of producing the unthinkable quantity of nearly 406,000,000 cubic feet daily. Not only do mammoth concerns like the Gas Light and Coke Company of London use it, but much smaller undertakings in different parts of the country, while it has made its way to Shanghai, in China.

Gas differs, however, very widely in price. The Gas Light and Coke Company, for instance, which is said to manufacture the brain-bewildering quantity of 22,000,000,000 cubic feet annually, charges 3s. per thousand cubic feet—and this is a reduction from a previous charge; but the South Metropolitan, which is said to manufacture little more than half that gigantic quantity, charges 2s. 3d., the same price which rules at Plymouth, while in some places the cost is as high as 4s. 6d.

The gas industry is, no doubt, still one of the great trades of the country. It is useless to quote figures, which may change from year to year, as to numbers of works in existence or the multitude of men employed; but the round, familiar gas-holder may be seen almost everywhere. Has this large industry a future, or is it destined to decline? No man can say. Electricity is a powerful rival; but the brilliant results of compressed incandescent gas and the immense use of gas for purposes of heating indicate that it will not yield without a struggle.

The grounds of the great Glasgow Exhibition in 1901 were radiant at night with a soft, white light, which experts declared to be the perfection of artificial illumination on a large scale. The light was not electric, but was produced by gas; it was used on the new high-pressure principle, and with incandescent burners. Four of the Keith burners grouped in one lamp yielded a resplendent light equal to at least 1,200 sperm candles, and quite threw into the shade the electric arc lamps by the water-chute, which were each supposed to be equal to 1,000 candles.

Photo: Cassell & Co., Ltd.

"WASHER AND SCRUBBER."

So successful, indeed, were the results that the authorities of the Turin Exhibition in the following year decided to illuminate their grounds in a similar manner; and during the winter of 1901-2 the south nave of the Crystal Palace at Sydenham was made resplendent by gas used on the same system.

Intensified gas-lighting—that is, the high-pressure system—was invented by M. Greyson, a Belgian gas engineer, in 1896; the incandescent mantle gas-lighting having been invented by Baron Welsbach, an Austrian,

about ten years previously. M. Greyson introduced a burner which, by the use of gas at a high pressure, and consuming only the average ten feet per hour of the ordinary burner, drew five times its volume of air per hour into the combustion; and using with it an incandescent mantle he obtained an immensely increased light, equal to that of more than 300 sperm candles.

This is the essential principle. But for the satisfactory working of this principle it is necessary to increase the pressure of the gas about four times more than that at which it is usually found in the mains; and his method of compressing the gas was not in practice very successful.

Several other plans were suggested; and one of the most satisfactory was the automatic compressor, introduced by Mr. James Keith, C.E.—the actual inventor being, we believe, his son, Mr. George Keith—and it was their method by which the very beautiful results were obtained at Glasgow and Turin. A suitable burner is also a necessity; but into the battle of the burners we need not enter.

Thus, while the opening years of the nineteenth century saw the gradual adoption of gas as an illuminating agent, the opening years of the twentieth century behold a remarkable development of its power and resources. A soft, white light beams from its best burners, and multitudes of persons use its flame as a fuel. Striving to hold its own, it seems more efficient than ever in diffusing light and warmth, and so supplying two of the great needs of mankind.

F. M. HOLMES.

Photo: Cassell & Co., Ltd.

SIFTING AND PICKING THE "BREEZE."

THE MANUFACTURE OF BISCUITS AND CAKES.

IT is not necessary for the purposes of the present article to enter into a long detailed history of the biscuit and the cake, although such a task would, no doubt, be attended with considerable interest. Among the early Romans it was the custom to break a cake above a bride's head as a token of good luck. This, however, was long before the custom of throwing rice, old shoes, and *confetti* after the bride. Cakes also performed an important part in matrimonial separations. When a husband and wife decided to part, a cake would be broken in twain, each retaining a half, which, like rosemary, was "for remembrance." But in these practical and matter-of-fact days biscuits and cakes are produced and utilised only for consumption.

It is not possible to lay down any specific figures in relation to this industry, for the simple reason that nobody appears to have thought it worth his while to compile a statistical work on the subject which should be kept up to date and as a book of reference. It is therefore only by comparison and computation that we can arrive at a representative aggregate. But it may be stated, on the basis of a calculation made by an authority in the matter, that there are about 25,000 persons employed in the manufacture of biscuits and cakes. The majority of these workers are, of course, attached to the leading firms. For instance, one house may have 1,500 or 2,000 employees, whereas a much smaller manufacturer may be unable to employ a hundred, or even a score.

Most of the large firms have a night and a day staff, and machines are constantly going. It is the aim of the makers to get the biscuits into the hands—or mouths—of the public as soon after production as possible. Practically speaking, they do not stock any goods, making one day what is required for the next day's delivery. Anyone who has eaten a biscuit warm from the oven, and compared its flavour with the article which may have been stocked for some time by a grocer or confectioner, will appreciate this promptitude.

BREAKING UP THE LARD AND BUTTER.

It is proposed in the present article to trace the evolution of the biscuit, from the flour in sack to the completed and baked comestible. The manufacture of biscuits is an industry that has advanced with giant stride, and a commercial traveller who, thirty years ago,

had but two or three competitors to wrestle with, has to-day to reckon with between thirty and forty. It is interesting, in passing, to note how the word "biscuit" has varied in the spelling through the centuries. In the fourteenth it was written "besquite"; in the fifteenth, "bysquyte"; in the sixteenth, "bysket"; and in the eighteenth, "bisket." The present method of spelling the word is, letter for letter, the same as the French. The derivation of the word is clearly shown in its composition — thus, "bis," twice, and "cuit," baked, or twice-baked—and has reference to the custom of doubly cooking biscuits which prevailed in the distant past, at a time when they were rendered so hard as to ensure their keeping for a great length of time.

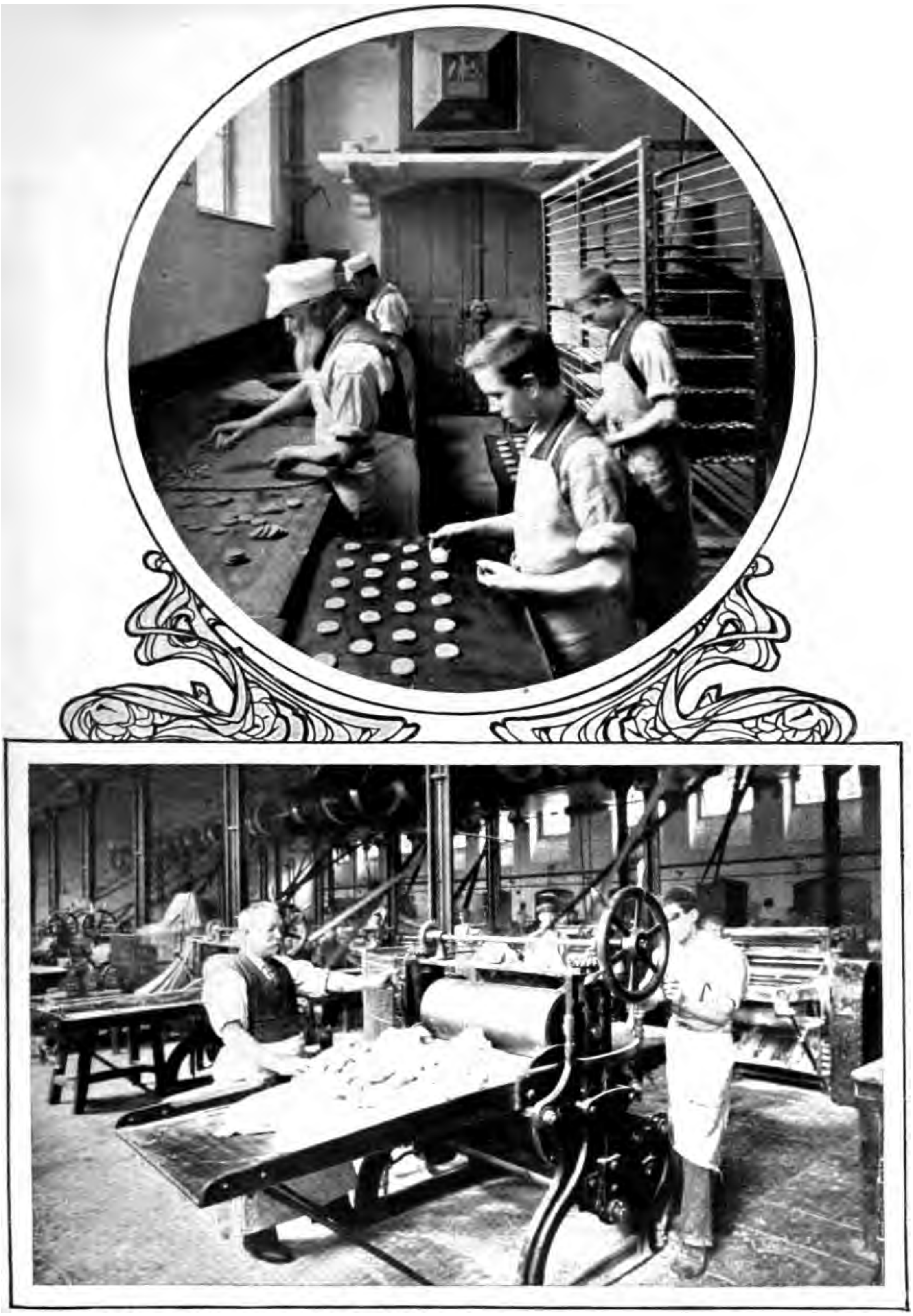
DOUGH COMING OUT OF THE MIXER.

Every biscuit manufacturer with a trade of any dimensions must have plenty of storage room, in which to keep the various ingredients in bulk. Flour, sugar, butter, eggs, almonds, dried fruits, essences, syrups, etc., all have to be received in large quantities nearly every day. They are, however, used directly, or soon after arrival. To all intents and purposes, it is a case of going in at one part of the building raw, passing straight through and out, cooked, at another. Some articles are kept in a cold storage chamber, in which the temperature is eighteen degrees below freezing point.

Various kinds of flour are used for different kinds of biscuits. There is also an elaborate process of blending employed. The flours are put into "hoppers," and during a single journey down and up again they are blended, mixed, sifted, and pass into a sack ready for use. The sifting is necessary not only on behalf of the consumer, but of the manufacturer also. Any foreign substance contained in the flour might not alone be detrimental to the flavour of the biscuit, but render a large stock unsaleable.

Pure butter is used for the rich class of biscuits, and lard for the plainer kinds. Both are broken and beaten up, the more easily to be manipulated. Eggs are also broken, turned into a large metal cup, and beaten up: almonds are blanched first by machinery, and finished by hand. The various ingredients, all having been duly weighed, are thrown into huge mixers, where they are thoroughly incorporated, and the dough kneaded.

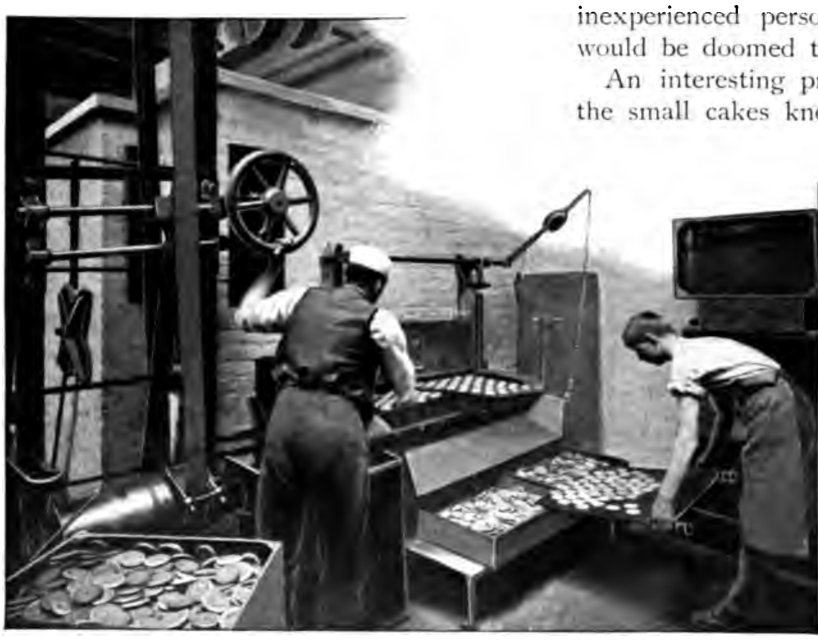
When the dough is taken out of the mixer, in a bulky and sticky mass, it is dusted with flour, and passed through various rolling machines or brakes, by means of which it is flattened out to the required thickness for the biscuits. Thus, in long sheets or ribbons, it passes along to be dealt with by the biscuit-cutting machine. This machine is fitted with rollers, endless webbing, a series of cutters on top, and carries beneath a procession of metal trays. There are men to feed and relieve the machine. One man introduces into the machine a length of dough, which is carried along on the webbing, beneath the cutters, for the biscuit shapes to be stamped out. The ribbon then divides, the waste rising on to a roller and being carried into a receptacle; at the same time the unbaked biscuits pass through underneath, and are dropped automatically on to the metal trays, which synchronise in their movement so as to receive the rows of biscuits from the cutters.



ROLLING THE DOUGH AND LAYING OUT HAND-MADE BISCUITS READY FOR BAKING.

The popular biscuit known as the "Colonial"—a long, straight biscuit, grooved on top—differs somewhat from other biscuits in the process of manufacture. In this instance the dough is forced through numerous apertures, in which are a number of metal protuberances, and these form the grooves as the dough passes through. The latter comes through in long strips, and is subsequently cut into shorter lengths, and laid upon trays in the manner already described.

The trays, on which are the raw biscuits, are taken off the machine and straightway placed in the oven. The latter is fitted with endless chains, upon which the trays repose, passing slowly through the oven, and being baked on the way. By the time they have arrived at the exit door they are baked to a nicety. The trays are taken from the oven, the biscuits removed into wooden receptacles, and placed on racks to cool. It is one continuous operation. The progress of the biscuits through the oven is exactly timed, the period varying, of course, with different biscuits.



BAKING BISCUITS: TAKING THEM FROM THE OVEN.

This method of baking is almost universally adopted, although there are different types of oven. One consists of a roomy chamber, in which is a kind of huge paddle-wheel, the biscuit trays being carried round the circumference, the process of feeding and relieving constantly going on through a long, narrow aperture in front. The wheel is timed to pause at the opening sufficiently long to allow of so many trays being taken off and so many put on. Then on its way again. One revolution of the wheel bakes the biscuits. There are also hand ovens and hand-made biscuits. This form of labour becomes necessary on account of the delicate composition of the biscuit, which would be entirely spoiled if dealt with by machinery. The work looks childishly simple, yet is very difficult, taking several years in which to attain proficiency. Any inexperienced person attempting the task would be doomed to complete failure.

An interesting process is the making of the small cakes known as Fairy cakes. A large tray, fitted with metal cups, passes under a series of feeders, which automatically drop the wet ingredients, in the form of "dabs," into the cups. The tray then passes on to the oven. The cleaning of the metal cups, prior to receiving the ingredients, is done automatically, and is also interesting. A number of circular "rubbers," which exactly fit the cups, are kept constantly and rapidly revolving. A tray of cups is held against the rubbers—one rubber to each cup—and in a trice the whole have been thoroughly cleansed. It is a wonderful time-saving contrivance.

We now come to the wafer making, which is a very interesting branch of the industry. A large circular chamber, heated by gas, is fitted with a series of large metal moulds. The liquid is poured into the latter, stamped with the name and pattern, and cooked in one revolution of the chamber. Twenty-four wafers are made in one operation, the sheet being subsequently divided up into single wafers, either by hand or by a cutting machine, also in one

CUTTING ICE WAFERS.

operation. After the wafers are cut they are ejected at the rear of the machine, where a number of girls are ready to receive and pack them. Another kind of wafer, known as the "Cornet," is fashioned in the form of a hollow cone. It is newer than the plain tablet, which is not now so popular. The implements and process of manufacture of this are curious. The stove is the same as in the case of the other wafers, but in the bottom half of the moulds is a series of conical apertures, having small holes at the bottom to admit air; the top half of the mould is fitted with a corresponding series of conical protuberances made to fit almost flush The liquid ingredients are contained in a metal reservoir, in the floor of which are a number of small jets, one to each aperture of the mould, and so arranged that they may be brought immediately over them. Thus, by means of uniform pressure, all the jets are made to eject into the apertures an equally distributed quantity of liquid. The reservoir is then removed, the mould closed down, and sent round the stove, reappearing at the mouth with the wafers cooked.

Another very interesting department is that in which the icing is done. Biscuits with fancy designs in sugar on top are familiar to most people, but possibly very few are aware of the method by which the effect is produced. It is done almost entirely by hand, and almost exclusively by girls. No doubt the latter are selected for the work on account of their deftness and lightness of touch. The icing sugar is contained in a small canvas bag which tapers to a narrow neck, and is fitted with a metal perforated end. The biscuits are spread out on a bench; the girl takes the icing bag in her right hand, and by applying slight pressure forces the contents through the perforations at the end, which adhere in a fancy design to the top of the biscuit. Then there is plain icing. For this a kind of artist's palette knife is dipped in the liquid, and lightly passed over the top of the biscuit.

ICING BISCUITS.

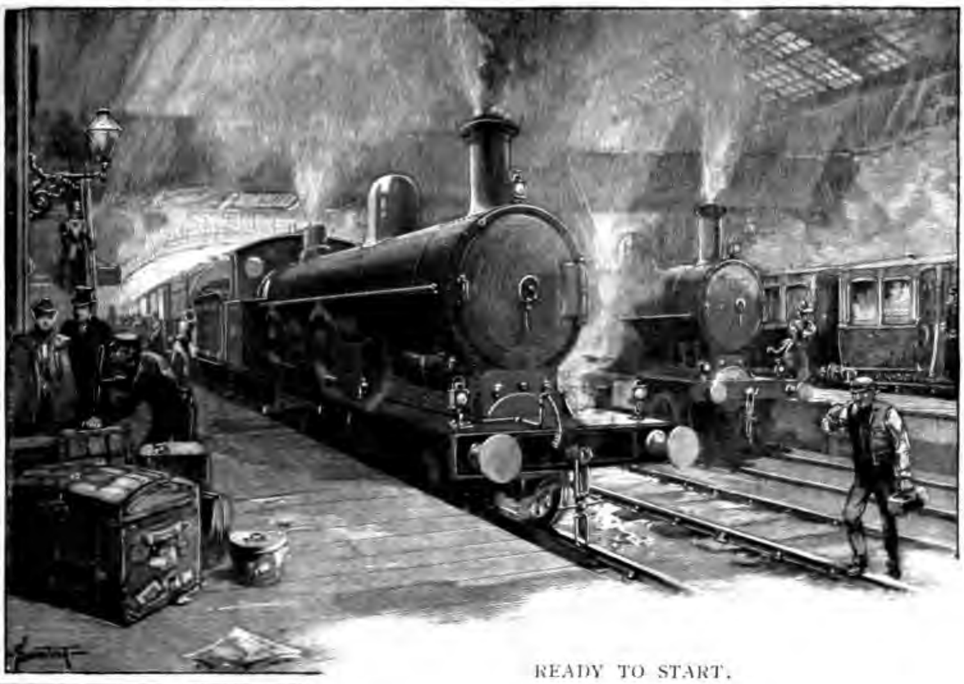
There is not much to add concerning cakes, the manufacture of which is practically embodied in, or attendant upon, the manufacture of biscuits. The processes are much the same up to the dough stage, when they go their different ways, biscuits to the rolling and cutting machines, cakes to the tins. The most popular cakes are those which are called "slabs," which are subsequently cut into wedges or slices by the retailer. In connection with this department, large quantities of lemon, orange, and citron peel are dealt with in their raw state, and preserved by special processes. Wedding cakes occupy a department of their own, but a recital of their methods of manufacture would partake largely of a repetition of the above. The component ingredients are richer, and the icing more elaborate; albeit full-blown roses and graceful scrolls may be formed while you wait.

There are hundreds of different kinds of biscuits and cakes, and new ones are constantly being put on the market. Certain biscuits, such as the "Osborne," "Oswego," "Milk," "Ginger Nut," "Lunch," etc., have a well established demand, but the public are ever looking for new forms, and will sometimes unwittingly welcome an old friend in a new guise. Fresh ideas for biscuits, both as regards shape and form and blending of flavours, are constantly being tried. The leading firms, whose names are household words, work well together. Among the best known may be mentioned Messrs. Peek, Frean and Co., Limited, at whose manufactory our photographs were specially taken for the purposes of this article.

This company's establishment at Bermondsey covers three and a half acres of ground, where between 1,700 and 1,800 people are employed. In one of the rooms there is a large mixer which during the Franco-German War was kept busy turning out huge quantities of biscuits for the relief of Paris. It is stated that 700 tons were despatched in a single day, being part of upwards of ten million pounds of biscuits supplied by the firm for the purpose within a fortnight.

H. L. ADAM.

SORTING AND PACKING BISCUITS.



READY TO START.

RAILWAY ENGINEMEN AND THEIR WORK.

ALTHOUGH the engine-driver is the most familiar of objects, besides being one of the most responsible servants of the public it is possible to imagine, the ordinary traveller has but the vaguest idea concerning his training and duties; while of his life off the footplate he may be written down entirely ignorant. In this paper we purpose dealing with every interesting phase of the engineman's career—the term "engineman" including not only drivers and firemen, but all who move and have their being among locomotives—and, since practice varies slightly with different companies, care has been exercised to treat the subject in as representative a manner as possible.

The engineman commences his career as a cleaner, and the candidate for footplate honours must have attained sixteen years of age. Many companies enforce a height standard for cleaners, viz. that the latter must stand 5 ft. 4 in.; while all insist upon a medical examination and sight testing operation. The term "cleaner" explains itself. Directly the engine is cold the cleaners, who usually work in gangs of four, the senior of them being known as the chargeman cleaner, get to work. They first rough-wipe the machinery, which is mostly covered with oil, and with the oily waste, after they have done everything else, clean the wheels. Of course, particular attention must be paid to the cleaning of the machinery; and, in order to stimulate vigilance, a suitable reward is given for the discovery of any flaw. The satisfactory completion of the cleaners' job is certified by the chargeman cleaner. When a cleaner has served three or four years he becomes a fitter's assistant.

Every running-shed has a staff of fitters, presided over by a foreman-fitter, who carry out ordinary repairs. Therefore, whilst serving a short apprenticeship with the fitters, the young engineman is able to pick up some technical knowledge of the machinery, with which he is already familiar by sight. The next step is that of shunting fireman, which permits him to mount the footplate for the first time in an official capacity. His little engine, however, is only employed about the yard, darting hither and thither in quest of trucks, marshalling

Photo: Cassell & Co., Ltd.

ON THE JOURNEY FROM LONDON TO TAUNTON. THE ENGINE WAS TRAVELLING ABOUT FIFTY MILES AN HOUR WHEN THIS PHOTOGRAPH WAS TAKEN.

both in order that a very dirty operation may be accomplished before the engine is cleaned up preparatory to its next trip, and to avoid delays on going out in the morning.

Having served his time as shunting-driver, pilotman, or engine-turner, the engineman is promoted in turn to the posts of third-class driver, working local goods trains; second-class driver, working main-line goods trains; and first-class driver, employed on passenger trains exclusively. Concerning the latter, a point to be emphasised is that there is no difference in rank or pay between him who drives the "crack" express and the driver of the slowest and most obscure branch-line passenger train. Most persons have an idea—and it is a very natural one—that the drivers of the fast or long-distance express trains are better paid than the remainder of their *confrères*; whereas

the latter when caught, and, in short, doing the scullion's work for the leviathans of the road.

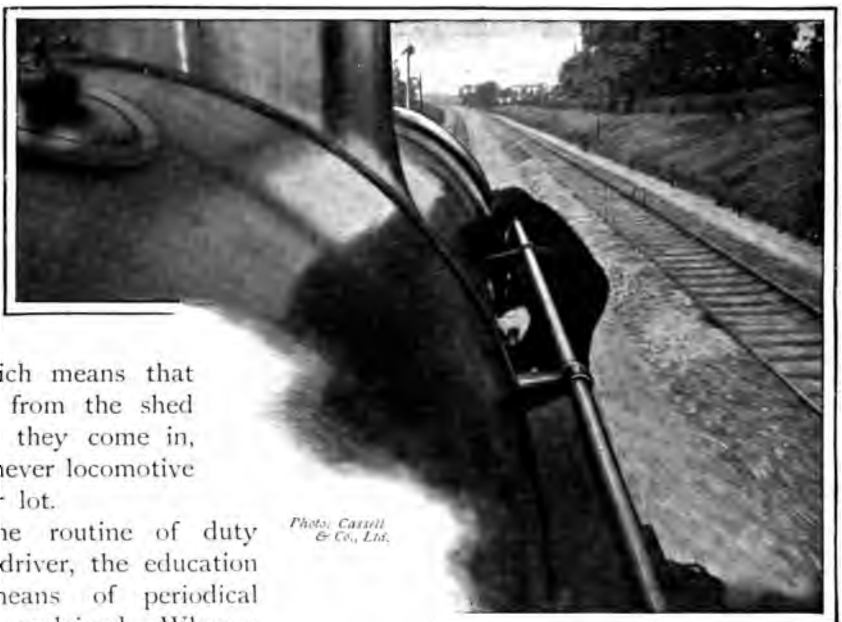
Having become a qualified fireman, the engineman is promoted to be what is termed a third-class one, whose duties are confined to engines working local, or "box," goods trains on branch lines, or to those employed in "banking," that is, assisting goods trains from behind when ascending inclines. The rank above the last-named is second-class fireman, who works on main-line goods trains; after which comes first-class fireman, or fireman of passenger trains, whether they be slow, local, or express. A first-class fireman is also understood to be capable of taking charge of an engine in emergency, having by now passed an examination for the purpose. In course of time the first-class fireman commences his career as an engine-driver from the bottom of the driver's ladder, that is, either in charge of a shunting engine or as an engine-turner. The latter post means that he meets and takes over the goods and passenger locomotives on entering the running-shed at the end of a trip, and remains in charge as driver whilst they shunt, turn round on the turn-table, coal, and steam gently into the shed to be stabled for the night. It must be explained that engines coal at the end of a journey,

Photo: Cassell & Co., Ltd.

FIRING UP

the former are only picked men, forming the engine-drivers' guard corps, so to speak, and receiving no extras save the honour and glory. A man, however, who has attained the rank of second-class driver need not seek promotion; he may, if he prefers it, remain where he is, in charge of goods trains. As a matter of fact, a man in the higher grade of goods train driving will make more money than is possible in the case of passenger train driving; but, on the other hand, his hours will be much longer, and his work altogether of a more arduous and less interesting description. On British railways the rule obtains that the same men — both driver and fireman—are kept to the same engines in the passenger and long main-line goods services. On all the great American and Continental roads, however, the system of "first in first out" has been adopted, which means that engines are sent out from the shed in the order in which they come in, and the men take whichever locomotive happens to fall to their lot.

Before describing the routine of duty peculiar to an engine-driver, the education of enginemen, by means of periodical examinations, must be explained. When a lad wishes to qualify for third-class fireman he must be able to read and write; and at this stage also the sight test is of a rigorous character. The danger of colour blindness in the case of signals is guarded against by showing him a tray full of skeins of wool of all shades of colour. The examiner picks out a skein, and the candidate has to match it from among the heap. Further, the latter has to be able to read lettered cards at stated distances. The examination for sight is repeated at every rung of the ladder till the engineman rises to second-class driver; it then takes place periodically, the interval between each varying with different companies—with the Great Western a driver over sixty years of age is examined every year—till he retires.



OILING AN ENGINE WHEN RUNNING AT EXPRESS SPEED.

Before a man becomes a first-class fireman he has to pass an examination in the mechanical working of the locomotive, which examination becomes harder and more searching as he passes through the different grades of driver. Every incentive to study is offered by the authorities in the shape of placing working models at the disposal of the men. But the officials who examine him are not satisfied with theoretical knowledge alone; they require convincing that, if anything goes wrong, he is in possession of sufficient practical experience to locate the mischief, and even effect repairs, as far as the tools placed at his disposal enable him to do so.

The driver and fireman come on duty together, usually at 6 a.m., having been called at their homes an hour or so previously by call-boys attached to the running-shed. At the time office each signs on, and the driver receives his keys, which open the tool bunkers on the tender and the padlock round the fire-irons. They then proceed to the running-shed office, where the driver signs a book certifying that he has read the notices there displayed. These notices refer to permanent-way works in progress; warning him if single-line working is in operation between any two points, if the relaying of the track is proceeding

Photo: F. Moore, Charing Cross Road.

PICKING UP WATER AT THE GORING TROUGHS.

elsewhere, or if the repair of bridges, crossing-gates, track-troughs, signal posts, etc., at certain specified points demands a sharp look-out, together with a reduction of speed. Needless to point out, very serious accidents might happen were not these notices carefully scanned. The board, however, also contains notices of a different kind, as, for instance: "Complaint is made of ashes being thrown from engines on to the point rods and signal wires at Mugby Junction. This practice must cease at once."

The driver next proceeds to the stores, where he obtains a supply of oil and waste, the amount of the former being booked to him, for he is allowed 1 lb. of waste per week merely to clean his hands. Generally he receives three different kinds of oil, namely, rape oil for machinery, a thicker oil for the cylinders, and paraffin or petroleum for the gauge and head lamps. At the stores also are issued to him the discs, if any, carried in front of the locomotive, to notify the destination of the train. Meanwhile, the fireman has gone to another part of the shed to obtain a supply of dry sand heated by special furnaces. After this the two men repair to their engine, which they find coaled, cleaned, repaired, and already making steam. Here it must be explained that, about three or four hours before the engine is required, a bar boy comes along with a torch-lamp, steel broom, and fire-box lifter, and enters the fire-box to clean it of clinkers and to re-arrange the bars. After him follows the fire-lighter, carrying on his shoulder a shovel of live coal, with which he starts the fire; while, till the driver arrives, the same man looks after the engine occasionally, to see that it is making steam properly.

When on the footplate the first thing that requires the driver's attention is the level of the water in the gauge glass. He must ascertain whether the level as it appears shows correctly the height of the water within the boiler by opening the lower cock. On being satisfied that the boiler is safe, the engine must be examined over a pit, the locomotive itself being placed in such a position that every part of it may be inspected without having the machinery moved. The driver then descends and carefully oils all bearings,

RUSHING PAST A STATION.

slide bars, eccentrics, etc., paying special attention to the crank-axle, or "big end," for the latter he cannot get at when on the road. When the examination of machinery has been finished underneath, the fireman must open the ash-pan door, so that the driver can inspect the ash-pan. The latter should be nicely raked out, and the fire bright and free from clinkers.

The engine is then taken out into the yard, where it fills up with water; while, before starting off to pick up his train, the driver must see that the coal on the tender is not stacked too high, and that it and the bunkers, fire-irons, and tools which are carried on the latter are so placed that they will not fall off when the engine is in motion. On coupling on to his train, the driver must ascertain from the guard what number of vehicles are behind him, so that he may know how to work his engine with economy, and exercise due care in descending gradients.

Once started, the driver must stand in his proper place upon the footplate, so as to be able to command the regulator, the reversing gear, and the brake handle. It is a relic of the old coaching days that still keeps these apparatus, and consequently the driver, on the "off," or right-hand, side of the footplate, which, since trains run on the left, and the signals and the station platforms are placed on that side of the track, is manifestly an inconvenient arrangement. However, the North-Western Company have long arranged their engine gear so that the driver can take up his position on the "near" side; and with the new engines of the London and South-Western Railway the gear has been transferred to what may be termed the proper side. The regulations direct that the driver must keep a good look-out all the time the engine is in motion, and the fireman must do the same when he is not necessarily otherwise engaged.

AN EXPRESS LOCOMOTIVE RECEIVING ITS FUEL FOR THE NEXT DAY'S TRIP.

A GOODS LOCOMOTIVE BEING HAULED INTO THE SHEDS.

As a driver must possess intimate acquaintance with the road over which he travels, meaning not only the maze of signals and sidings, but its varying gradients as well, it stands to reason that his journey area is restricted. In fact, it is this which accounts for the engines belonging to each running-shed being grouped with their drivers and firemen in separate links or gangs. As a rule, where passenger engines are concerned, the links are so arranged as to permit of the engines returning to their sheds and the men to their homes the same night. The engines of main-line goods trains, however, travel farther afield, necessitating what are termed "double home trips."

For example, a man living at Westbourne Park takes a train down to Swansea, sleeps there, and returns home the next day. Most companies provide excellent lodging houses at the principal junctions for enginemen engaged on double-trip jobs—those of the

OVERTAKING A GOODS TRAIN.

North-Western Company being regular hotels; while, if this is not done, as is the case on the Great Western system, the rule is to furnish men with a list of approved lodgings, and to allow them 1s. 6d. per night, or, in the event of their going to a strange place, 2s. 6d. for each of the first three nights they spend there. In ordinary circumstances a driver, on arriving at his destination, takes his engine to the shed, turns it, fills up with water, and then rests until it is time for him to start home again; but neither he nor his fireman may leave their engine without special permission. On his return home the driver hands over his engine to a turner, after which he goes to the running-shed office, where he makes out his returns for the day, reports any irregularity that may have occurred, and enters in a book kept for the purpose what repairs he thinks necessary. Here also he learns at what hour he comes on duty again. A driver has a different time with a train practically every day, in order to equalise turns and give him plenty of rest in between. Leaving the shed office, the driver proceeds to the time office, where he signs off, and hands in his keys.

The duties of the engine-turner have already been explained; but it should be added that it is he who takes the engine to coal, the amount received being booked to the driver.

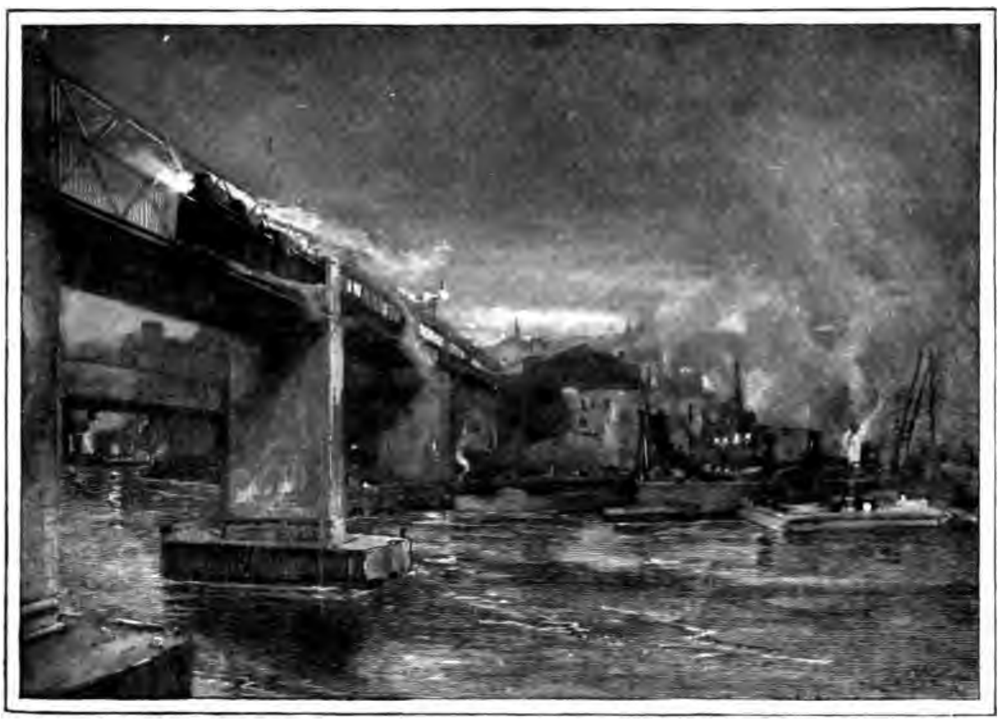
A few lines must now be devoted to the staff of a running-shed, which is officered by a foreman, a foreman-fitter, and several inspectors, the latter being responsible that the men and engines are ready to leave at the right hour and in a fit state. The staff itself consists of a number of skilled workmen, copper and brass smiths, etc., for executing repairs; while in addition to the cleaners there are tube-cleaners, boiler-washers, lighters-up, and sand-men. The four last-named are as often as not enginemen who have failed to continue a footplate career owing to defective eyesight or inability to obtain a driver's certificate. Every engine is washed out once a week. Previous to this operation the smoke-box has been cleaned and perfectly cleared of ashes, so that the wash-out plugs

can be easily taken out, and that there may not be any ashes to be washed into the tubes. The engine is then taken into a shed and placed over a pit, the leaden wash-out plugs removed, and the washers-out tackle the boiler with a hydrant. After this all the glands have to be re-packed, tubes cleaned, and ash-pan and damper put right. The driver has to attend during the operation, which is finally passed by the shed-foreman, and for doing so he receives a full day's pay.

The maximum pay of a driver is 8s. per day, that of a fireman, 5s. Enginemen work ten hours per day, with overtime and Sunday work paid for at the rate of eight hours per day. The earnings of a first-class driver average well over £3 per week, those of a fireman £1 less, but the former can also earn a substantial quarterly premium for saving of coal and oil. The post of driver is not the highest an engineman can rise to. A thoroughly steady and well-educated man may be promoted to locomotive inspector or shed-foreman, in which case he receives a salary of quite £200 per year.

The companies are very far from being unmindful of the material welfare of the men they employ; and, indeed, it is their constant study to maintain the most cordial and friendly relations with them. Many excellent free pension schemes have been devised for enginemen, notably that of the London and South-Western Company, who give one at sixty-five, also at sixty years of age, if the man's health fails, provided he has been twenty-five years in the company's service. It only remains to add that the life of engine-driving has in recent years undergone great changes for the better. In the improvements of engines, in personal comforts, and in reduction of working hours locomotive enginemen may find much upon which to congratulate themselves.

H. G. ARCHER.



OVER THE BRIDGE TO GLASGOW.

THE CUTLERY INDUSTRY.

THERE are one or two interesting features about the great cutlery industry of Sheffield which distinguish it from almost every other trade or craft carried on in the British Isles. Its antiquity everybody knows of, but still more singular is the fact that it is even now to a great extent carried on

A FORGER AT WORK.
(Photo kindly supplied by Messrs. J. Rodgers & Sons, Ltd., Sheffield.)

by methods exactly similar to those in vogue three or four centuries ago.

The industrial revolution of the nineteenth century, which substituted machinery for hand labour, and made the factory system everywhere predominant, scarcely touched the cutlery trade. Only in one or two of the processes involved in the making of a pocket or table knife have mechanical contrivances been successfully or largely introduced.

The Sheffield grinder, his clothing smeared with "wheelswarf," sitting before his whirring stone, still bestrides his "horse" in the same way as did his predecessor in the days of Good Queen Bess, and in holding the blade to the stone he uses just such a rude handle, formed of a cleft twig, as suggested itself to the earliest cutlers who carried on their handicraft by the side of some woodland brook, in the days when machinery was unknown, and when in Roche Abbey or Beauchief Abbey, not so far away, the monks were painfully illuminating their beautiful missals. Nor has the forger changed his methods one iota.

Time, of course, has wrought many changes in the accessories of the trade. The grindstones are now run by steam, and in some cases even by gas, although there are still a few of the old-fashioned water-power shops on the streams which find their way into the Don near Sheffield. The popular tradition that Sheffield is the original home of the cutlery trade is incorrect. Cutlery was first made in London; but we find it flourishing at an early period, before the days of Chaucer, in the district round about Sheffield, known as Hallamshire. The transference occurred probably when the iron industry left Kent and Sussex, its original home, for the Midlands and the North, so as to be near the coalfields. From Chaucer's day down to very recent times the forges and grinding "wheels"—as the shops containing grindstones are termed—were scattered about a wide area on the banks of every convenient stream. It was the introduction of railways and the growth of other manufactures which caused the modern city of Sheffield to grow up as the nucleus of the commercial activity of the district.

Although the last few years have witnessed some developments in the rapid production of cutlery, it is a fact that the best knives are still made throughout by hand. In Sheffield, "cutlery" means any tool having a cutting edge, but for the purpose of this article we shall only speak of pocket and domestic cutlery. In the manufacture of a first-class pocket or table knife the services of a number of workmen, skilled in very different ways, are called into play.

In the first place, a good knife must be made from refined steel made of the very purest Swedish iron ore. The forging of

cutlery is a trade to itself, and in former days each workman had a forge at his own cottage door, and, being paid by the "piece," he was one of the most independent of artisans. We shall see as we go along that the peculiar feature which formerly characterised the manufacture of cutlery, and which still to a great extent survives, is its dependence upon a number of independent craftsmen or small employers having their own workshops and receiving their remuneration by "piece." To-day there are a few modern, large, and self-contained cutlery factories in the city, but we doubt whether there is one where the cutlery sold is produced entirely on the premises.

But let us return to the forger, with whom the making of the knife begins.

Starting with a bar of steel made from best Swedish iron and rolled to a convenient width and thickness at one of the rolling mills in Sheffield which prepare metal for the various trades, by a series of quick blows with his hammer the craftsman forms a rough semblance of a blade; the work being performed at a "hearth" or furnace similar to that of the ordinary village smithy. But by far the most delicate and important part of the work is that of hardening or tempering, upon which the cutting power of the instrument depends. A sharp, durable edge is everything to a knife, and indifferent hardening will destroy the very best steel. Hardening is accomplished by heating the blade and plunging it suddenly into water or oil. If the blade is heated to an extreme temperature the edge will be as brittle as glass, and liable to snap, while if the temperature be too low it will be too soft to cut. The workman has nothing to guide him except the tint of the hot metal, assisted by his experience. The universal plan is to produce a too high temper at the first operation, and to let it down by one or more heats and coolings. The superior properties of Sheffield cutlery is believed to be largely due to the softness and peculiar property of the water used for hardening. It is also a tradition that the more the water is used for the purpose the better are the results, and it is said that many of the tanks have not been emptied for a great number of years.

MAKING THE BOLSTER IN THE "PRINTS."

(Photo kindly supplied by Messrs. Mappin Bros., Sheffield.)

MARKING MAKER'S NAME ON BLADE AND SETTING THE BLADE.

(Photo kindly supplied by Messrs. Mappin Bros., Sheffield.)

Pen and pocket knife blades are made wholly of steel, but in table cutlery the tang or shank and the bolster (the raised portion between the blade and handle) consists of iron, which the forger welds to the steel blade.

GRINDERS AT WORK.

(Photo kindly supplied by Messrs. J. Rodgers & Sons, Ltd., Sheffield.)

The branch of the trade necessitating the most skill is that of the pen and pocket knife cutler. Many years of experience, accompanied by artistic taste, a correct eye, and nice judgment, are essential for the putting together of a high-class article. His parts consist of blades, springs, linings, pins, and any special articles which may be wanted—such as corkscrews, cigar-holders, buttonhooks, prickers, etc. Except in the case of the very largest firms these articles are produced from outside the factory, each forming a separate trade. There are old craftsmen who have made nothing all their lives but corkscrews, springs, or some one of the other articles mentioned. The patterns of pen and pocket knives made in Sheffield number more than 10,000, and the prices range from 4d. to five guineas each.

After the forger comes the turn of the grinder. We have stated how the grinding "wheels" were formerly to be found dotted along the banks of local streams. A modern grinding "wheel" is quite a different affair, being usually a company undertaking, in which steam power is provided for a considerable number of sets of grindstones, the actual users of which work independently of one another and pay a rent to the company for the facilities provided. These grinders are, in fact, small employers, or "little mesters," to use the vernacular phrase: they undertake to supply one or more cutlery firms with ground blades, and pay men and boys by piece to do the work. Only a few cutlery firms grind on their own premises.

The blades, having been ground, are then lapped, glazed, and polished on emery and other stones, and taken to the cutler, whose duty it is to put the parts together and turn out a finished knife.

The making-up of table knives is a more simple affair. Many kinds of material are used for the scales of spring cutlery and the hafts

GRINDING TABLE KNIVES.

(Photo kindly supplied by Messrs. Mappin & Webb, Sheffield.)

of table knives—ivory, bone, wood, stag horn, buffalo horn, ox horn, mother-o'-pearl shell, tortoiseshell, celluloid, etc.—the cutting and preparation of which furnishes employment for several different classes of workmen and small employers. Hafting material dealers buy their ivory and stag horn at the auctions held quarterly at Antwerp, London, and Liverpool. It is then cut up into handles and scales and sold to the cutlery manufacturers. Three or four of the latter, however, also attend the sales, and supply their own requirements direct.

The most largely used hafting material to-day is celluloid—a manufactured article closely resembling ivory and vastly cheaper, and, although not equal to its natural prototype, it is very nice to look at, and wears well. Ivory itself is likely to become more and more a luxury, seeing that the advance of civilisation threatens "my lord the elephant" with gradual extinction, and the supply of other hafting materials is also contracting through the same cause.

CUTLER AT WORK.
(Photo [illegible] Messrs. J. Rodgers & Sons, Sheffield.)

Machinery has lately come into use in the manufacture of second-rate cutlery. Table knives are now forged by the goffing hammer—a small steam hammer which delivers blows at a great speed, so as to imitate as nearly as possible the work of a hand forger. There is also another process by which blades are "flied," or stamped out of a sheet of metal; but these "flied" blades are inferior even to the goffed ones, through lack of the hammering, which has a beneficial effect on the wearing quality of the steel by closing its fibres. Although blades can be produced rapidly and cheaply by these means, there is no doubt that the cheapest table knife in the long run is the hand-forged blade, hafted in best African ivory, which, if taken care of, may be handed down from generation to generation, and last practically for ever. At the present time a plant of American machinery for forging, grinding, glazing, and finishing table knives entirely by machinery is being worked by a syndicate, but only meagre support has been given to the venture at present. It would appear that the conservatism of the British public is a more serious bar to progress in industrial methods than the much talked of conservatism of the manufacturers. It is most difficult to sell machine-made cutlery, simply because the shape and appearance of the articles appear strange.

The typical Sheffield scissor is made in the same form as it always was—the blade, shank, and bow, or ring, being forged out of one piece of steel. In the case of larger scissors, however, the blade is forged on to a shank and bow of common steel, so saving expense. The Germans, using a lower grade of steel, stamp out the complete scissor, blade, shank, and bow; and they have in recent years secured the bulk of the world's trade so far as cheap scissors are concerned. Many German scissors are made and used in Sheffield itself, and lately scissors drop-forged in Germany from Sheffield steel are imported in large quantities and finished in Sheffield, on account of the scarcity of local forgers. Many people look upon the scissors trade of Sheffield as a dying industry, and, owing to the small number of apprentices now entering it, the means of production are dwindling in an alarming way. The fancy work on scissors is done by means of filing, which fifty to a hundred years ago was a

HAFTING TABLE KNIVES.

(Photo kindly supplied by Messrs. Mappin & Webb, Sheffield.)

very notable art in Sheffield. All sorts of pretty designs, such as monograms, with decorative engraving of flowers or birds, were carved on the bow and shank; and for exhibition purposes a workman would sometimes spend four months ornamenting one pair of scissors in this way, the value of the finished article being one hundred pounds or more. The delicate tracery of some of these patterns resembled lace. With the decline of fancy work for ladies of title elaborate scissors have practically gone out, but such little ornamentation as remains in vogue is still done by hand filing.

The razor is another important item of cutlery which Sheffield still supplies to all parts of the world, except America. Until the passing of the McKinley tariff, about twenty years ago, America was a great customer for Sheffield razors as well as other classes of cutlery. Indeed, it is said that a greater proportion of people shave in America than in any other part of the world; and the effect upon the Sheffield manufacturers of the Act referred to may be imagined when, by a single stroke of the pen, this lucrative connection was annihilated. All that Sheffield exports to America now is a few high-class, expensive pocket knives, of a kind so little in demand that it is not worth the while of the Yankee maker, with his peculiar methods of production, to tackle. The discovery of hollow grinding by the Germans about thirty years ago revolutionised the razor trade. It was some time before the Sheffield manufacturers appreciated the significance of the new departure, and when they did for a long time they bought hollow-ground razors from Germany, and in some cases imported German grinders to teach the trade. The Germans introduced new and improved processes of polishing and burnishing superior to our own, and they are still regarded as leading the way in the matter of hollow-ground razors—though this is more tradition than anything else, inasmuch as Sheffield can now turn out an article of this class equal to anything on the market. In this branch of the cutlery trade, also, the scarcity of apprentices constitutes a serious danger. Razors are forged and ground in a similar manner to knives

and scissors, except that the concavity in hollow-ground blades is made by holding the blade lengthwise to the stone instead of crosswise.

Sheffield has a monopoly of the cutlery trade of the United Kingdom, and it is probably no exaggeration to say that up to twenty years ago Sheffield manufactured cutlery for the world. The passing of the McKinley Act robbed her in a moment of practically the whole American trade, the United States from that time beginning to supply their own requirements. Of late years Germany has been a keen rival both in English and foreign markets, and a considerable quantity of cutlery is now made in Austria, Sweden, and Switzerland, while Portugal and Russia are the latest competitors to enter the field. Remarkable instances might be given of the value of cutlery trade marks, due to the fact that it is impossible for the inexpert buyer to tell good cutlery from bad. Hence, if a really good knife is wanted, it is better to buy one bearing the mark of some firm of repute. A good deal of the foreign machine-made cutlery is of inferior quality.

It must be admitted that serious dangers threaten the supremacy of Sheffield in her oldest manufacture. The trade suffers from the want of mechanical progress, and from the survival of antiquated methods which tend to check enterprise. Some indication has been given of the way in which the trade is split up amongst the "little mesters," and, although many firms have recently put themselves into a position to manufacture cutlery on more modern lines, the ill effects arising from lack of co-ordination are not altogether outgrown. The system of piece-work which still obtains is in many ways remarkable; even in a factory cutlers will pay rent for the place where they work, with something for materials, light, and fires, receiving so much per gross for the articles they put together. They are not workmen in the ordinary sense, and this unusual relationship makes it difficult in some cases to apply the regulations of the Factory Acts. The most serious danger menacing the trade is, however, the want of a proper succession of skilled workmen.

It is in the most highly skilled branches, such as the making-up of pocket cutlery, that there is the greatest shrinkage in the supply of workmen. That the position is somewhat serious may be seen from the simple fact that although the world's requirements have grown enormously, there are actually fewer people engaged in the manufacture of cutlery in Sheffield to-day than at any time during the last hundred years, and the means of production are undoubtedly less.

JOHN WHITAKER.

AN IVORY STORE.

(Photo kindly supplied by Messrs. J. Rodgers & Sons, Ltd., Sheffield.)

BARGE LIFE.

Photo: Cassell & Co., Ltd.

A YOUNG BARGEE.

STEPPING forward, slowly and steadily, and scarce quickening his pace, even when the whip cracks like a pistol-shot near him, an old horse plods meditatively on the canal tow-path. He is hauling behind him a heavily laden barge which seems almost to glide over the water by its own volition, for sometimes the tow-rope hangs quite loosely between its gaily painted post in front and the old horse on the path.

At the stern of the barge, near the little chimney from which light smoke is flying, stands a healthy and comely woman with a child in her arms, and on shore, beside her father, not far from the horse, trots a little girl.

Here they all are, the bargee and his family, living on their barge, and conveying at the rate of about three miles an hour a heavy load of bricks to the heart of mighty London.

Look in the little cabin at the stern of the boat, near which the good woman is standing. Your first impression would probably be of bright blue and red colours. A very gaudily depicted Windsor Castle might strike your eye from the wooden panelling, then a soldier in startling uniform, anon a mermaid, and then, perchance, a peacock in more brilliant dress than ever Dame Nature designed in her most lavish moods. Bargee and his family evidently like bright colours.

But a cheery stove beams red and warm close to the hatchway door—a stove shaped something like an egg, its upper part narrowing to the pipe which rises as a chimney without. Beyond the stove extends a set of cupboards, and opposite, on the right hand as we enter, stretches a broad seat on which a bed can be spread at night; in front of us, at the end of the cabin, between the cupboards and the broad seat, projects a smaller seat, where probably the chubby children may rest their healthy limbs.

A bright brass lamp, polished to shine like gold, gleams near the stove, a few cooking utensils hang here and there, and a small clock ticks loudly, making—like some persons—great noise for such a little thing.

The cabin is the bargee's home, and it reminds us of the tiny kitchen of a well-kept cottage, with, of course, certain characteristic differences, due to the fact that it is built on a floating craft. In spite of apparent disadvantages, the bargee, as a rule, prefers his home and his life to a London lodging. And it is doubtful if he is unwise in his preference, for really his cabin, with the fresh air he can always obtain outside, is surely better than many a city slum.

In fine weather the life of a bargee is, no doubt, pleasant enough, as he glides smoothly through the quiet country, bathed in the bright sunshine and the fresh air, and surrounded by the song of birds. But his life has other aspects, as when he voyages through a dreary manufacturing or mining district, when rains fall heavily and the wind is cruel, when snow lies thick on the tow-path, and ice hampers or blocks entirely the passage of his boat. Yet the liking of bargee for his calling is genuine enough.

There are varieties of bargees as of other folk, and not all of them may present the picture just described. The tendency in these days is for a number of barges to be owned by one firm, and some of the proprietors will not permit women and children on their boats, only unmarried men or widowers are employed, or, should a man have a wife and young family, they must dwell ashore. On the other hand, some large barge-owners permit the wives and families to dwell on the boats, subject to the regulations of the law; and barges may still be found which are

BARGES IN THE "POOL" OF LONDON

BARGES ON THE THAMES OPPOSITE GREENWICH HOSPITAL.

owned by the bargee himself. The legal regulations, passed in 1877 and amended in 1884, only permit a man and his wife and two children to inhabit a cabin of a certain size; but some barges are fitted with two cabins, one fore and aft. Further, the sanitary inspector and the "School Board man," as the bargees call him, are abroad, and the boat children have to attend school like their fellows on shore. Some difference has thus been caused in the use of canal boats as dwellings and fewer women and children are to be found aboard than a comparatively few years ago

It is difficult to give an accurate idea of the average earnings of canal-boatmen, because they are paid so differently Some, no doubt, receive a weekly wage but others are remunerated by a fee for the trip, and others at a rate per ton according to the merchandise they carry. Bad weather involving a stoppage of their craft would inflict serious loss on these latter, should the masters not make them some allowance. Perhaps an estimate of from eighteen to twenty-five shillings weekly would not be far wrong as an average. Living is cheap for the bargee, especially if he uses the boat as a dwelling A man owning his own barge and horse might do fairly well if he were thrifty and business-like, and it would appear that there are worse callings, and certainly more unhealthy trades, than that of an inland boatman.

But, perhaps, many persons may be surprised to learn that the conveyance of freight by barges, on inland waterways, still forms a somewhat large industry in the United Kingdom; they may have thought that the railways had killed the traffic. Such is not quite the case. For a time, undoubtedly, the prosperity of canals was greatly checked by railways, but about 1878-80 it began to revive, and, in the opinion of some among us, the barge industry is likely to increase rather than diminish.

Quite an army of men are employed, estimated to be about a hundred thousand in number: nearly four thousand miles of canals and inland navigations are open for trade, while about forty million tons of freight are conveyed in the course of the year. In fact, so complete is the system that you could float from London to Liverpool on inland waterways, and as far back as 1836, there was, it is said no place in England south of Durham that could be found fifteen miles from a canal or navigable river.

This statement may possibly have been an exaggeration, but the system was, and still is, very extensive. Some of those old canals have no doubt, been allowed to run dry; others, again, have been converted into railways—about 120 miles, it is said, altogether; but there still exists a great network of inland navigation in the country, an important centre

of which, so far as England is concerned, may be found at Birmingham. Here several waterways meet and a canal reservoir is maintained.

The freight conveyed on these inland navigations, including navigable rivers, is, as may be supposed, heavy and bulky; such as bricks, ore, coal, and lime, straw, sand, and manure. At Paddington Basin, where the Grand Junction Canal may be said to end, you may see many examples of this water-borne merchandise. Here is a sailing-barge, with tall mast and picturesque brown sail, which has voyaged up the Thames, and entering the Regent's Canal through Limehouse Dock, has been towed through London until it rests at this wharf. Its cargo is a load of broken cockle-shells for powdering the gravel paths of Hyde Park.

Next to this vessel lie half a dozen or so towing barges which have brought heavy loads of bricks from the country; yonder lie a fleet which will transport refuse from dust-carts out of the town; hard by are waiting other barges to float away with street sweepings and stable-manure to be used on the land.

Not long since, salt used to be brought to London by barge, but the salt wharf at Paddington now appears to have passed into other hands. On the Thames you would find cargoes of clay, probably from Poole in Dorsetshire, floating quietly up to the Potteries at Lambeth. The clay may be brought by vessels to the docks far down the river, and then be borne by lighters or barges higher up the stream; but barges are also built to sail the sea, and the barge itself may have conveyed the raw material round the coast to the place of manufacture. Glass bottles from the Continent have often been conveyed to this country by sea-going barges. Those brown sails, looking so picturesque at the mouth of the Thames, are not outspread for the river alone.

A characteristic feature of a freight barge, either with or without sails, is of course that it is a flat-bottomed boat very suitable for conveying heavy and bulky goods, if speed be no object. In canals where sails are unavailable, the barge is still usually towed along by a horse walking gravely on the tow-path beside the water; but steam has made its appearance on the quiet inland waterway as elsewhere, and trains of barges may be seen tugged along on other inland waters as well as on the

PASSING UNDER LONDON BRIDGE.

Photo: Cassell & Co., Ltd.

FIVE MINUTES' GOSSIP.

Thames. When a horse tows along two craft, one behind the other, the second is called, in canal language, a "monkey" barge. The horse indeed, as a rule, still holds its own on the tow-path ; and dotted at intervals on the canal banks stand shanties or stables, often in connection with a public-house, where Dobbin may be installed for the night at the modest charge of fourpence. This fee pays for the shelter and the bed on which the animal may repose its weary limbs. Not far distant the barge is moored out of the passage-way, and the bargee and his family, having obtained such food and drink as they may require from the inn, retire to their cabin, shut their door, and sleep as soundly and as comfortably as their countrymen ashore.

The slowness of barge traffic is not altogether due to its motor power being chiefly haulage by horses. Passing through the numerous locks adds greatly to the delay. Thus, between Paddington and Tring—a distance of some thirty-two miles by rail—there are no fewer than forty-five locks by which the canal surmounts the rising ground. Then the barge finds itself on the high level ; but before very long meets with seven other locks to enable it to descend again with safety to a lower plane. The first lock out of London is at Cowley, near Uxbridge, and the time occupied by a barge in passing from London to Tring is about two days. It is clear, therefore, that perishable goods would not form suitable freight, but for heavy freight such as bricks and timber, or for bulky merchandise such as straw or manure, the barge offers a very suitable and, no doubt, very cheap means of conveyance.

The two great waterways out of London are, of course, the Thames running eastward and the Grand Junction tending north-west. The Thames communicates with several other waterways at intervals and running north and south ; it also joins the Severn by canal. The longest canal tunnel in England—known as the Sapperton—is, it may be said, in parenthesis, on the Thames and Severn. It is over 11,000 feet in length. Horses are not used for haulage here, but the men push the barges through.

PASSING THROUGH A LOCK.

Photo: Cassell & Co., Ltd.

The Grand Junction communicates with North and East London by means of the Regent's Canal, and entering the Thames at Limehouse; but it also joins the royal river again about eleven miles west of London, through the Brent at Brentwood. As it passes on to the north-west it throws out branches to Aylesbury and to Buckingham, and loses itself finally in the Union, leading to Leicester, and the Birmingham, which not only leads to the metropolis of the Midlands but to a number of other canals. Among these are the Oxford, the Birmingham and Worcester, the Birmingham and Coventry, and the Grand Trunk, which onward wends its way to the Bridgwater Canal and to Liverpool.

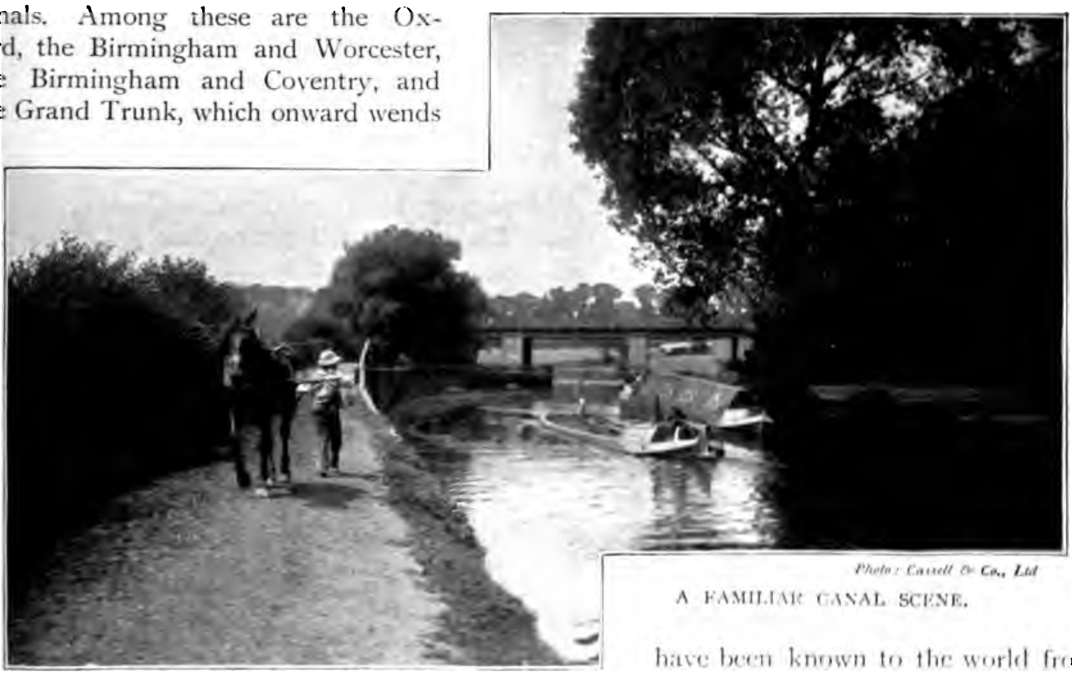


Photo: Cassell & Co., Ltd

A FAMILIAR CANAL SCENE.

From the Mersey the Liverpool and Leeds Canal takes its way, and at Leeds joins the Aire and Calder, which communicates with the Ouse and Hull. These two, therefore, form a waterway across northern England, just as the Grand Junction, Birmingham and Grand Trunk form a north-westerly, and the Grand Junction, Union, and the rivers Soar and Trent form a northerly navigable line through the country.

Suggestions have been made that electric wires should be stretched above the canals, and electric motors being fitted to the barges, they should travel somewhat after the fashion of electric tram-cars, empowered through the wires overhead; but though this system would quicken the pace on stretches of water free from locks, it would not obviate the delay occasioned by passing through these necessary works.

It would seem that travel on our inland waterways must be comparatively slow; but that is no reason for their neglect. They carry much heavy freight now, and could convey more, especially if a uniform gauge of lock and canal could be adopted. Canals have been known to the world from the earliest ages, but their great extension in England did not occur until the latter half of the eighteenth century. The need for more efficient communication between various parts of the country became keenly realised, and the development was largely due to the skill of James Brindley and the energy of the Duke of Bridgewater. It was about that time that the greater part, at least, of the English canal system came into existence. For a hundred years or more the patient horse and the long and heavy boat have formed a picture in the peaceful country-side, and as part of [illegible] changes the barge [illegible] and [illegible] [illegible], forming [illegible] and [illegible] feature in the [illegible] life of Old England.

F. M. HOLMES.

ARRIVAL OF THE WOOL.

THE MANUFACTURE OF WOOLLEN AND WORSTED.

IT may safely be said that every inhabitant of these islands—however ragged his habiliments—has some wool on his back. Among all peoples living in temperate climates, the wearing of wool fabrics of some sort is indeed practically universal. The first fibre ever woven into cloth was probably goat's hair or the wool of the primitive mountain sheep, and the term "spinster" carries us back to the time when it was the part of every maiden to hold the distaff and spin the yarn from which the clothing of the family was to be woven.

Before the advent of the locomotive there were two high roads from London to Scotland. They correspond pretty closely to the east coast and west coast railway routes of to-day, the one passing through Doncaster and York, the other through Warrington and Preston. Within the parallelogram formed by these four towns—roughly sixty miles by thirty—very nearly the whole of the two great textile industries is carried on. The great Pennine chain running north and south divides the counties of York and Lancaster, and cuts this limited area into two fairly equal portions, the Lancashire side being given up to cotton, the eastern or Yorkshire half mainly to wool.

WOOL SORTERS AT WORK.

It is a land of high moorlands and rushing streams, and its people have many of the strenuous characteristics of hillmen all the world over. Leeds, Bradford, Halifax, Huddersfield, Wakefield, Batley, Dewsbury, Keighley are all large and important towns, almost united into one vast city by smaller towns and villages innumerable, every one of them engaged in some branch or other of the wool industry. According to the report of the Chief Inspector of Factories for 1889, the number of persons employed in the woollen and worsted industries was 297,053, of whom nearly 168,000 were

females. This return, of course, takes no account of the immense number of persons engaged in the handling and transport of the raw material, in the collection, packing, and distribution of the manufactured article, or in catering for the manifold wants of the workers themselves. Altogether the population dependent upon wool for a livelihood cannot be far short of three millions.

It is estimated that the value of the wool worked up in one year is not less than £23,000,000, and that in the course of its progress to the shelves of the tailor and draper it is increased in value between three and four fold. Whence comes this vast mass of material?

A hundred years ago we were dependent almost entirely upon our own sheep. There are nearly 27 million sheep in Great Britain, and the weight of one year's clip of their wool is about 140,000,000 lb., of which one-sixth is sent away in the raw state. We import, in addition, for consumption here some 400,000,000 lb. of wool, mohair, alpaca, camel's hair, and goat's hair. The great bulk of it comes from Australia, New Zealand, and South Africa; but a considerable portion, perhaps 20 per cent., comes from the River Plate, Asia Minor, the hill country of North India, and even Tibet.

The great marts for imported wool are London and Liverpool, and periodical auction sales are held in both places, which are attended by buyers not only from Yorkshire, but from France, Germany, Belgium, and even the United States. Of late years some of the largest users send out their own buyers to purchase at sales in the colonies. The sale room in the Wool Exchange, in Coleman Street, London, during the progress of one of the six series of sales held there annually, presents an interesting and exciting scene. As many as twelve thousand bales of wool, averaging 400 lb. in weight each, and worth from ten to twenty pounds a bale, are disposed of by auction at one sitting of two or three hours, and the sales go on day after day, sometimes for three weeks at a stretch. The merchants who deal in the home-grown wool are called woolstaplers, and they either go round to the farmers and haggle with them about the price, or attend the annual wool fairs in the wool-growing counties of England and Scotland. Most of the Irish wool is collected by dealers, and finds its way either to Dublin, for sale there, or direct to Bradford and Halifax, where the whole business, so far as this country is concerned, is finally focussed.

WASHING WOOL.

A generation ago the spinner bought the wool and combed or carded it himself, and in what is called the woollen branch of the trade this is still a common practice, but the tendency of late years has been to specialise the various processes. Very much of the wool which comes to us is, in the first instance, bought by top-makers. On arriving at the top-maker's warehouse the bales are cut open. The wool, which has been tightly compressed perhaps for six or nine months,

PREPARING THE WOOL.

is shaken out, fleece by fleece, and divided into "sorts," the best of the fleece being thrown into one basket, the skirtings—*i.e.* the parts about the neck and legs of the sheep—into another, and so on. But there are many different classes of wool. The long and lustrous staple of the pure Lincoln breed differs from the short, dull, soft South Down as the coat of a polar bear does from that of a chinchilla. The pure merino fleece from the Riverina of New South Wales differs almost as widely from the strong Leicester cross-bred from New Zealand. Each class —and there are many intermediate grades—has characteristics which render it suitable for most varied purposes. The wool which is used for the Union Jack at the ship's masthead would never do for an infant's christening robe or the green cloth of a billiard table. Hence there is very little admixture of classes, the object of sorting being to separate the qualities. There is, however, a very broad division made between combing and carding wools. A lady in combing her hair holds a portion of it in one hand, holding the comb in the other. Wool which is too short to be held by the "nip" of the combing machine must be carded. This dividing line closely corresponds with that which separates the worsted and the woollen manufactures. Worsted goods are made from the long or combed wool, woollens from the short and carded wools.

COMBING.

When the sorting has been done the wool goes to the comber. It

must first be scoured. All unwashed fleeces carry a considerable amount of the yolk or natural grease of the animal, and some Australian and South American wools contain as much as 60 per cent. of sand, dirt, and grease. The washing is effected by machinery in what is called a "bowl," though it bears no resemblance to that useful domestic vessel. The washbowl is a long, deep iron trough, in which the wool is immersed in a bath or "sud" of hot water and soap, being slowly passed from one end of the trough to the other by a series of reciprocating brass forks. The bowl has a false bottom, into which the sand and dirt settle by gravity. On emerging from the end of the bowl the wool is squeezed between rollers, and usually at once passes into a second bowl, where, of course, the water is cleaner, and often into a third and even a fourth. When it finally emerges it is pure and almost snow-white, though still carrying many grass seeds, burrs, and other entanglements. After drying by subjection in a closed chamber to the action of a stream of hot air, during which time it is being constantly tossed like the grass in a hayfield, the wool is ready to be combed or carded, as the case may be.

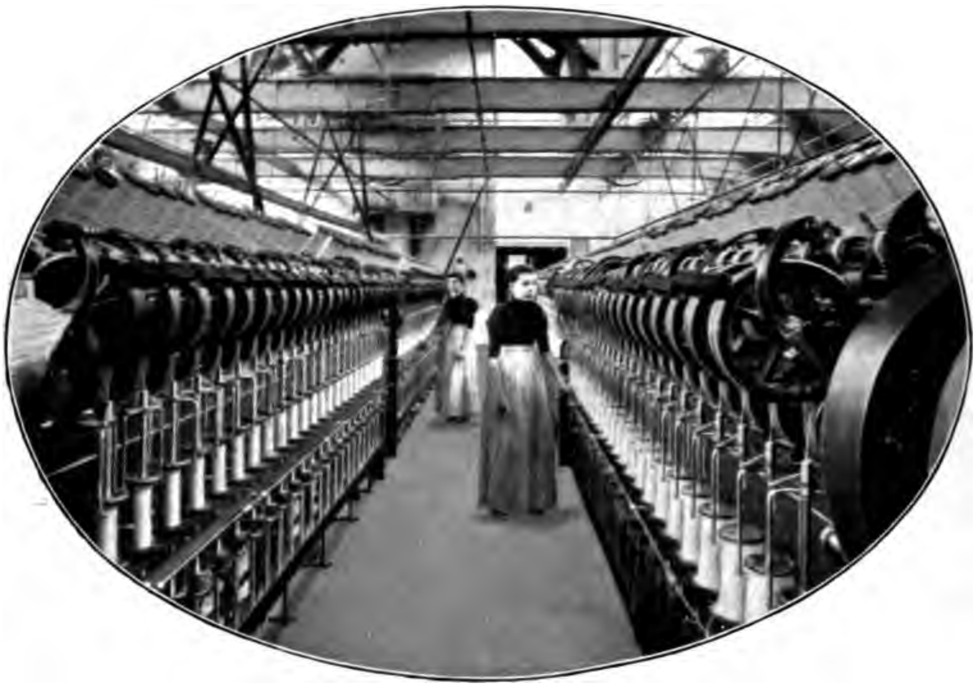
"DRAWING."

The combing machine is one of the marvels of mechanical invention, and it has several forms, but the type which has finally been adopted in this country is known as the great circle comb. It consists of a large brass ring, about four feet in diameter, in which the steel pins of the comb are set in concentric circles, the strongest teeth on the outer ring, the finest on the inner, there being usually four or five such rings. The pins or teeth of the comb, which revolves horizontally and very slowly, are heated, and by an ingenious arrangement of fluted rollers the wool is gradually drawn through the teeth of the comb from the outside, coming away from the inner edge absolutely free from impurities and with every fibre laid parallel with its neighbour. The shortest of the wool is left behind, and is automatically picked out of the teeth of the comb before it receives a fresh supply of wool. This short stuff is called the noil, and the combed wool which comes off in a continuous rope is coiled up into a ball or "top." The top-maker, then, is one who buys wool, sends it to be washed and combed, and then sells the

product to the spinner, for whom it is now ready.

Spinning, the conversion of wool into a twisted thread or yarn, is accomplished in two different ways—either by the spinning frame or jenny, as it was once called, or by the self-acting mule. The latter is used only for very short fibres, such as cotton or the shortest wools; and wool spun on the mule is called a woollen yarn, whereas that spun on the frame is a worsted yarn, and each has a character of its own. In worsted spinning the thick rope of combed top is first reduced in thickness and correspondingly increased in length by being passed through a set of drawing machines. These draw out the staple by the simple device of passing it between pairs of fluted rollers, each successive pair running at a higher speed than the last, so that it emerges as a thin thread, but still with no more twist in it than will just serve to hold it together. In this form it is wound on to large wood bobbins, and it is then known as a roving.

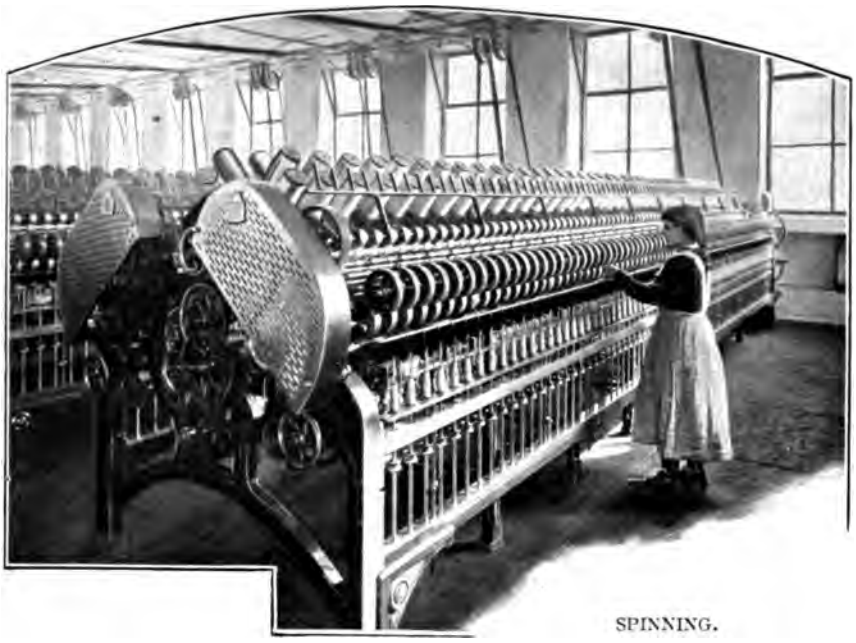
The spinning frame consists of a row of several hundred spindles, all revolving at one uniformly high speed, and a corresponding set of rollers, partly of fluted steel and partly of wood covered with leather, each spindle on the frame having its own train of rollers. The full roving bobbins are placed upon pegs above the rollers, and a small bobbin or spool is put on to the spinning spindle. When the machine is started, the roving passes between the revolving rollers and is finally drawn out or "draughted" to the required fineness, and then the rapid revolution of the spindle gives the fibres a twist or spin, converting what was merely a few parallel fibres into a strong thread or yarn. As the process of spinning goes on, the yarn is wound on to the small bobbin on the spindle, and when all the bobbins are filled the machine is stopped and a gang of little boys and girls quickly change the full bobbins for empty ones, the threads are all given a deft initial turn on the empty bobbins, and the machine is again ready to be started There is no more fascinating sight than to watch a gang of "doffers" go through these evolutions.



"ROVING."

In woollen spinning the shortness of the fibre necessitates a somewhat different preliminary method for obtaining the roving, and the spinning is accomplished without any "draught." On the mule the spindles are not fixed, but are carried on a long carriage, which can be run out from the stationary

WEAVING OPERATORS AT WORK IN A GREAT YORKSHIRE FACTORY.



SPINNING.

part of the frame upon which the roving bobbins are placed for a distance of six or seven feet. When the machine is started the carriage is run out, each spindle drawing after it a length of the roving. Then, when the carriage has reached the limit of its traverse, the spindles, revolving with great rapidity for a few seconds, impart the twist or spin to the whole length of thread which has been run out, and at the instant when the required spin has been obtained they stop, the carriage runs back to its former place, the bobbins on the spindle winding up the spun yarn as the carriage returns. Then, of course, the cycle of operations is repeated.

It will thus be gathered that in worsted spinning the operation is a continuous one, whereas in mule spinning it is intermittent. The one produces a smooth, round, regular yarn of great strength, all the fibres of which are carefully twisted parallel to one another; the other a yarn which has the fibres mixed up in an irregular fashion, with their ends sticking out like the hairs of a caterpillar, but, for this very reason, giving a yarn of much softer "handle." It is this vital difference in the method of spinning and in the result attained which constitutes the main distinction between a worsted cloth, such as a serge or corkscrew, and a woollen cloth, such as a Melton or Amazon.

It was the introduction of the power-loom, scarcely more than a century ago, that led to the riotous assemblies and mill burnings so vividly depicted by Charlotte Brontë in "Shirley," and more prosaically recorded by many less-known local historians. In principle, however, even the most elaborate loom of to-day differs but little from the simplest form of the loom used by Egyptians 4,000 years ago. It is only, after all, an apparatus for crossing threads under and over one another alternately, and so binding them that they shall not come loose again. Those threads which run through the whole length of the piece constitute the warp, those that cross it the weft. The warp threads are maintained in a state of tension, and when one half of them are lifted clear of the rest by an automatic arrangement, the bobbin of weft contained in the shuttle is thrown across and between them. Then the position of the warp threads is reversed, the shuttle with the weft is thrown back again, and so the process goes on until the piece is finished.

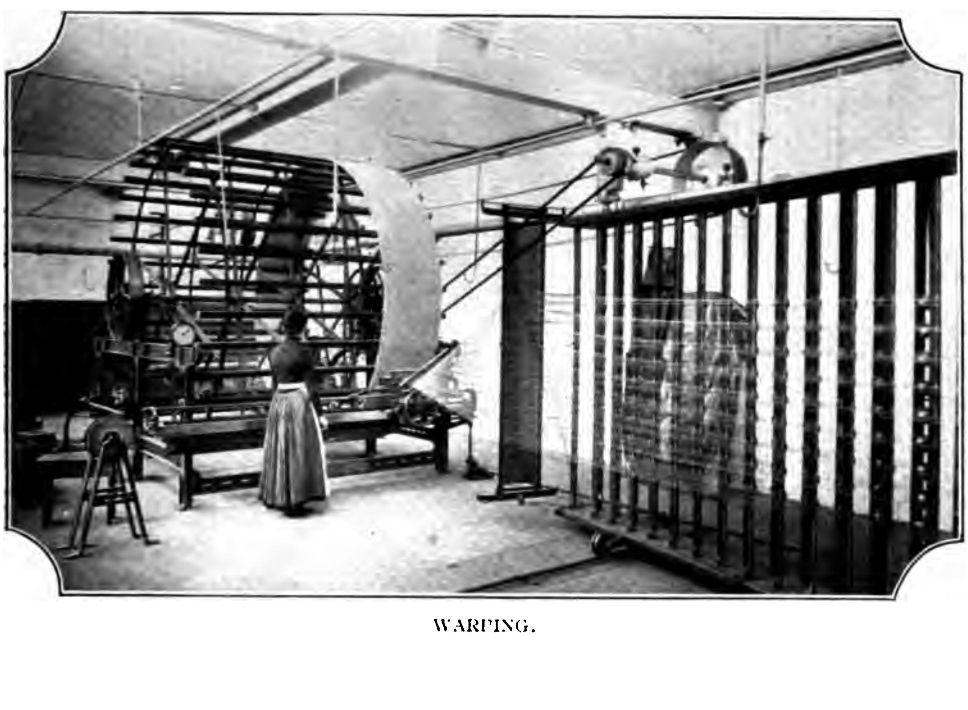
Pattern, or design, is obtained by varying the number of warp threads which are lifted at each "pick" of the shuttle, by changing the character or colour of the weft, and by a multitude of other devices which are too technical for description here. Fabrics in which the pattern is obtained by the use of coloured threads or by the admixture of silk threads are known as "fancies," those which

are woven and subsequently dyed as "plains," though the design may vary widely. But whether plain or fancy, light or heavy, wide or narrow, all cloth must after weaving be subjected to a variety of operations all comprehended in the useful term "finishing." It must be cleansed from all impurities, it will be steamed, scoured, milled, shrunk, stretched, raised, cropped, singed, pressed, and finally rolled into the perfect web ready for the merchant's warehouse or the draper's counter. The "finish" which it is desired to impart determines the way in which the cloth shall be treated after it leaves the loom of the manufacturer, and no two kinds of material are dealt with in exactly the same way.

Technical education, the improved taste of the people, and the development of invention have brought about an immense improvement in the variety and beauty of wool textiles; and the Education laws, by raising the age at which children may work in factories, are silently working an economic revolution which is regarded with some apprehension. For the spinning mill child labour is held to be essential, very much of the weaving is done by women, and in both these departments there is of late a marked decline in the numbers employed, while there is no compensating increase in the employment of adult hands. There is consequently a fair field for the ingenuity of the inventor who will aim at making the spinning machinery and the loom automatic in their action.

ARTHUR R. BYLES.

The illustrations accompanying this article are from photographs specially taken for the purpose at Messrs. John Foster and Son's manufactory, Bradford.



WARPING.

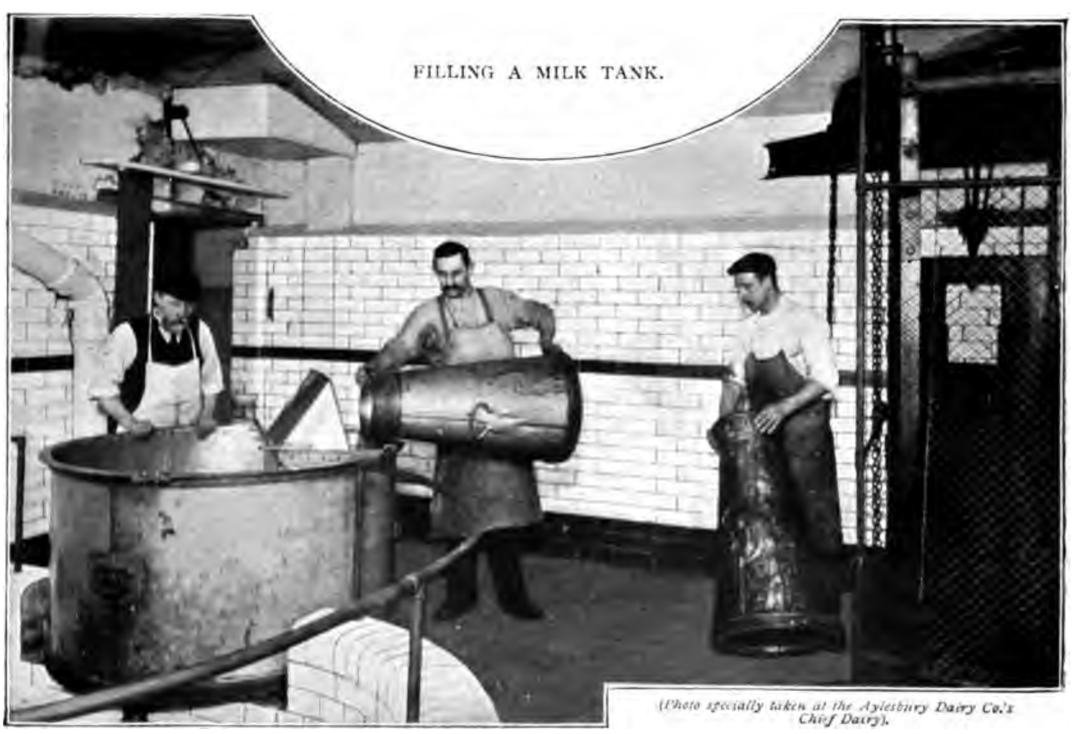
IRISH FARMERS BRINGING MILK FOR BUTTER MAKING.

(Photo: L. S. Baker & Son, Birmingham. By permission of the Mayfield Dairy Company.)

BUTTER AND CHEESE MAKING.

LIKE many other of our national industries, dairy-farming suffers from a keen foreign competition. A vast quantity of butter is imported into this country, but in spite of this fact it is stated that considerably more than 100,000 tons of butter are made annually in the British Isles.

Butter making has, of course, a department by itself in the conduct of a dairy-farm. It is probable that an abstract knowledge of the work is pretty general, but as many ingenious appliances have been introduced into the industry, a brief account of the various processes of manufacture should be of interest. The description herein presented is that of a system in operation on a large farm, which is the centre of an extensive area of distribution. It may there-



FILLING A MILK TANK.

(Photo specially taken at the Aylesbury Dairy Co.'s Chief Dairy).

fore serve, generally, as a type of the many other similar establishments to be found in the British Isles, and which are all conducted more or less on the same lines.

MILK PASSING THROUGH REFRIGERATOR.

Butter making does not require so much work or detail as cheese. Most dairy-farmers make a speciality of one particular branch of the industry: with one it may be cheese, with another milk, and so on. But all, without exception, make butter, either on a large or a small scale. In the case of cheese makers and milk dealers and suppliers, it is the superfluous milk which is converted into butter. A large tank is kept for the reception of this, which is subsequently carried away through pipes to a warm chamber below, in which the temperature is slightly higher than that of the milk when it comes from the cow. It then passes through a refrigerator into a separator, the skim escaping on one side, and the cream through a tap on the other. The former is forced up again into another tank, and being too poor for any other purpose is sold to bakers, who use it in making pastry.

BUTTER ON REVOLVING WORKER.

The cream is caught in pails, which are stood in a bath of cold water for the space of twenty-four hours for the cream to "ripen." It is then turned into a wooden churn, when in twenty minutes it is thick enough to be taken out on small wooden bats, placed in a tub, washed, and put upon the revolving butter-worker. The latter is a large wooden contrivance, propelled by machinery, and an idea of its character may be gathered from our illustration. The butter is placed on a circular table, sloping outwards, and with radiating corrugations; immediately above this is a protruding cone of wood, also corrugated. The two work in opposite directions, and the butter between them is effectively "worked." When this is complete it is ready to be packed in whatever form it is required. Where a quick distribution takes place, it is immediately done up into 1-lb. and 2-lb. packages. From the beginning to the end the material is never once touched by hand.

The above remarks apply to the best class of butter. There are, of course, inferior articles made—such as margarine—into which certain processes of salting and colouring enter largely into the manufacture.

WORKING A LARGE CHURN.

(Photos specially taken at the Aylesbury Dairy Company's Chief Dairy.)

Cheshire is the heart of our cheese-making industry. Although cheese is produced in various forms, the bulk of that consumed

consists of four different kinds, namely, Cheshire, Cheddar, Gloucester, and Stilton. Of these, the first two are by far the most popular, judged from the amount consumed. It will be noticed that all these cheeses derive their names from the county or district in which they are made. The first and third speak for themselves, and are comprehensively christened ; the second is named after a village, Cheddar, in Somersetshire ; and the last is from Stilton, in Huntingdonshire. Although all these places can claim to have initiated their respective dietary industry, a large quantity of cheese is imported into this country, placed on the market and sold in the name of the home-made article. A great deal of the cheese which is consumed in Great Britain as Cheddar or Cheshire is nothing of the kind, if locality counts for anything, but comes from America, Australia, or New Zealand. Of course, the process of manufacture may be imitated, but there is such a knack -a mysterious, intangible kind of skill in cheese making that one might justifiably question the capacity of the imitator. Even experienced British dairy-farmers are at a loss to adequately explain what is the precise nature of the agency which conduces to a thoroughly good cheese. Dexterous handling of ingredients and implements is, of course, an important factor, but the question of temperature appears to have a considerable bearing upon the subject, though experts differ on the point. Farmers have been known to produce good cheese under conditions, so far as temperature is concerned, in direct contradiction to all recognised and accepted notions on the subject. But they could not explain how their success came about.

Photo: Cassell & Co., Ltd.

DEVONSHIRE BUTTER MAKERS AT WORK.

The principal processes of cheese making are much the same all through, but for the purposes of illustration we will take the production of a Cheshire cheese, at Lea Hall Farm, Aldford.

Here we have a typical Cheshire dairy-farm. Everything about the place is scrupulously clean. We follow a consignment of milk into an apartment which contains a long cheese-vat on wheels. The vat is metal-lined, and there is a hollow space all round, between the outside casing and the receptacle, which holds the milk. This is a hot-water chamber, used only in the cold

weather. At the end is a bright metal union, attached to which are pipes running off right and left, one passing through a division wall into another apartment. A metal strainer is fixed on to the side of the vat, through which the milk is poured. Two kinds of milk are used — the perfectly sweet, and that which is "on the turn," the latter being added for the purpose of creating acidity and aiding in the ripening of the cheese. All the milk having been poured in, rennet and colouring are introduced. The former is measured in a graduated glass, and five ounces are used to 170 gallons of milk. The colouring is a dark-brown vegetable solution, and one and a half ounces are used in the same quantity of milk. The use of this ingredient in no way affects the flavour of the cheese, nor improves it beyond adding the yellowish hue familiar to most people. Yet without it, or should the colour be too deep, the cheese would be rendered comparatively valueless, or, at all events, considerably reduced in value.

The rennet causes the milk to coagulate, and then ensues a process of separation, the curd settling at the bottom and the whey rising to the top. If the cheese is intended to be kept any length of time, the vat will be kept heated to 90° or 94°. If it is for quick sale, and this generally happens in the cold weather, the temperature is reduced to, say, 85°. Periodically it is stirred up for half an hour at a time, and when the "setting together" takes place, it is broken with a cutter—an implement consisting of a series of long narrow blades—for half an hour. In a few hours from the pouring in of the milk, the whey is run off, disclosing the curd in a close layer at the bottom. It is then cut up into blocks or slabs, and subsequently broken up as small as possible with the hands. Salt, which acts as a preservative, is next thrown upon it, to the extent of ½ lb. of salt to 20 lb. of curd. Finally, the curd is passed through a machine fitted with two rollers, in which are rows of metal teeth. This breaks the curd up into very small pieces, which are then placed in circular perforated metal jars, each one representing a cheese, and set near a fire, or in a cheese oven, to preserve the temperature. After a few hours of this treatment, during which the metal jars have been occasionally reversed in position, the curd is put into the presses. The material is placed in a small wooden hooped barrel, lined with a cheese-cloth, and fastened at the top with a tin fillet. The weight brought

IRISH FARMERS DELIVERING MILK FOR BUTTER MAKING, CAPPAMORE.

(Photo: E. S. Baker & Son, Birmingham. By permission of the Maypole Dairy Company.)

Photos: Cassell & Co., Ltd

CHEESE MAKING IN CHESHIRE.

1. PUTTING RENNET INTO THE MILK. 2. CUTTING THE CURDS.
3. SALTING AND GRINDING THE CURDS. 4. FILLING CHEESE TINS.
5. TURNING A CHEESE IN PRESSING HOUSE AND PUTTING IN PRESS.

to bear upon it is increased each day, till it finally reaches about half a ton. In four or five days the cheese is turned out.

From the presses the cheese is taken to a lift and carried to a store-room above, where it is laid out on the floor upon a bed of straw. In about a week from the time the making begins, the cheese is sometimes in the hands of the consumers. The factor visits a farm, and thrusting his tester into the various cheeses, decides on their fitness for the markets. If the surface is rough, it is ripe and good; if, however, it presents a smooth appearance, like a piece of yellow soap, it is too fresh, and must be kept a little longer, the work of ripening not having been sufficiently well done. It depends entirely on the application of acidity as to how long it must or may be kept.

But let us return for a moment to the whey. It passes through a pipe from the vat to a slate-lined tank in the floor of the adjoining chamber. The virtue in it is converted into butter, and the residue or waste is pumped, by means of steam power, a considerable distance to the piggery, where it forms a delectable item of diet for the porcine population. It requires very careful handling to produce good butter from whey, and only the experienced and most skilful of dairy folk are entrusted with the work.

The cheese which is easiest of digestion is that which is old, dry, and crumbling, but it is not by any means a marketable article. The most difficult to digest is that which is new and "close." Green in Cheshire cheese is not desirable, although it is in Gorgonzola and Stilton. In the case of the last-named the rotting is encouraged by means of acidity, and by thrusting into it brass and copper skewers. In the making of it the curd is not broken up; nor, of course, is any colouring used. There are large cheeses made without colouring, but farmers prefer making the other

Photo: Cassell & Co., Ltd.

THE CHEESE IN THE PRESSES.

kind, for the sufficient reason that they are more marketable.

It is estimated that from 130,000 to 140,000 tons of cheese are made in the British Isles in a year, and 105,000 tons of butter. The imports amount to over 126,000 tons a year. The yearly imports of butter and margarine are more than 200,000 tons. The busiest month for cheese making is May.

A great deal of butter is made in the south-west of England, and also in Ireland. At Cappamore, in Ireland, it is not at all unusual for as many as a hundred farmers to send their milk to one dairy, and it is a pretty sight to see the milk being brought in. The carts, drawn by donkeys, are driven by peasant boys and girls, often without shoes or stockings. The procession of carts is sometimes a mile long. The milk is delivered at one side of the dairy and then weighed, and the cart goes round to the other side to take away separated or skimmed milk, which is used for feeding calves.

H. L. ADAM.

Photo: Cassell & Co., Ltd.

CORNER IN STORE-ROOM. A FACTOR TESTING CHEESE.

HOW PAPER IS MADE.

IN the whole range of the industries few things are more arresting than the transformations wrought in the process of making paper. The thought of dirty, unsightly rags, the mere refuse of another industry, being converted into paper smoother than cream, and almost as white as driven snow, is more marvellous than a good many fairy stories. But even more wonderful is it to think of anything so frail and unsubstantial as paper being made out of hard, solid wood. Yet such is the fact: the sheets which to-day we see being delivered in the form of huge rolls at the newspaper offices in the neighbourhood of Fleet Street, and which to-morrow morning we shall find on our breakfast tables, were but a few weeks ago growing as timber in the forests of Norway or of Canada!

Photo. F. Downer & Son, Watford.

RAG SORTING HOUSE, CROXLEY PAPER MILLS.

The supply of rags is, of course, not illimitable, and as the activity of the printing press increased, about the middle of the nineteenth century, manufacturers were glad to supplement it with esparto grass from Spain and from Northern Africa. Before long the supplies of this material also began to show signs of exhaustion; and both in Spain and in Algiers the Governments felt it necessary to carry out investigations with a view to preventing its undue exploitation. As the years sped by, and the demand for a cheap press continued to grow more urgent, manufacturers were forced to cast about for something less costly than esparto; and in the seventies they found in wood the cheapest of all known substances for the making of paper. All three materials—rags, esparto, and timber—are now in use, either singly or in combination. For the best kinds of paper, including hand-made paper and superior notepaper, linen and cotton rags still hold the pre-eminence. Esparto takes the second place, and from this it is that the majority of our better-class books are made. But the cheap newspaper press draws its supplies almost exclusively from wood.

If for a moment we glance back to the dawn of history we shall find that we have rather less reason for priding ourselves

SHEDS WHERE THE PULP IS STORED, SITTINGBOURNE.

upon our superiority to our remote ancestors than might at first be supposed. What does the very word "paper" come from but from "papyrus," the reed which the ancient Egyptians manufactured into a writing material? Even the conversion of wood into paper was no discovery of the nineteenth century. In the dim and distant past the Chinese, who plagiarised so many things besides, were able to make paper out of sprouts of bamboo, and later they pressed bark into the service, besides hemp and rags and old fishing-nets. Yet no self-respecting person would say of these old paper-makers of far Cathay that everything was fish that came to their nets!

If, however, the ancients were able to make paper—of a sort—out of the same unpromising things as we ourselves, we none the less have something of which we may vaunt ourselves. The raw materials are much the same, but how marvellously have the processes changed! That which had to be done slowly and laboriously by hand is now effected with almost inconceivable rapidity by complicated and delicate machinery, so true in its construction, so nearly perfect in operation, that it may almost be left to look after itself. In these days a single machine, turning out its thousand miles of paper in a week, gets through as much work in four-and-twenty hours as would have occupied an army of men for a year under the old conditions.

ARRIVAL WHARF, SITTINGBOURNE.

Photo: F. Downer & Son, Watford.

BEATER HOUSE, CROXLEY PAPER MILLS.

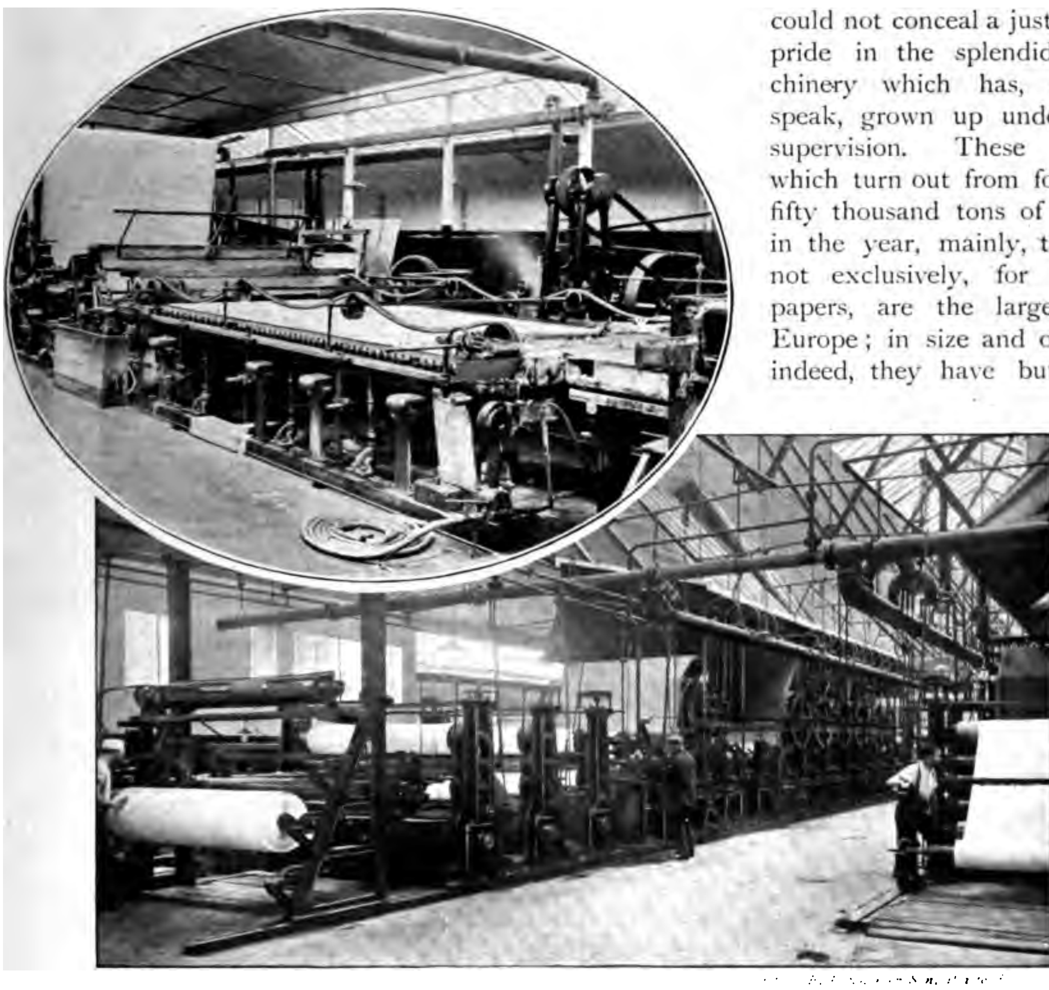
That the Paper-making industry has of late years advanced by leaps and bounds may go without saying. In England and Wales the number of paper-mills is 233, in Scotland 59, in Ireland 8. Altogether, therefore, there are some 300 mills in the United Kingdom engaged in the manufacture of paper, and it is impossible to set any bounds to the development of this important industry. The counties in which the manufacture is most extensively carried on are Lancashire, which has forty-four paper-mills to its name; Kent, which has thirty; and Yorkshire, which has twenty-seven. Between them these three counties have to their credit more than one-third of the total number of paper-mills in all Great Britain and Ireland. The Kentish mills include those of Messrs. Edward Lloyd, Limited, at Sittingbourne, more generally known as the *Daily Chronicle* mills; the *Daily Telegraph* mills at Dartford; and the Tovil mills (near Dartford) and the Horton Kirby mills (South Darenth) of Messrs. A. E. Reed and Co., who also own the Merton Abbey mills in Surrey and the Wycombe Marsh mills in Buckinghamshire. In another of the Home Counties, Hertfordshire, are the extensive mills of Messrs. John Dickinson and Co.—the Croxley mills, near Watford, to which some of our illustrations relate; two others at Hemel Hempstead, and a fourth at King's Langley.

Multitudinous as are the uses to which paper is put, one is hardly prepared to find that there are at least eighty different "species," while of "varieties" the number is past counting. Besides writing paper and blotting paper and printing paper, there is manifold paper and typewriting paper, tracing paper and drawing paper. Then—not to speak of the many kinds of brown paper, of which the production is enormous—there are papers for bank-notes and bills and cheques, for hosiery and pins and needles, for collars and caps, for cigarettes and tobacco, for butter and tea and groceries, for portmanteau boards and carpet felt, for railway tickets, and for a host of other purposes, all of them made by more or less different processes.

The wood from which, as I have said, the cheapest printing papers are made does not reach our manufacturers in its natural state, but in the form of what is known as pulp. So far, indeed, is it removed from

its original condition that no one not in the secret, seeing a bale of wood-pulp, would ever guess that these flakes of what looks not unlike rough, thick cardboard were once spruce firs—for this is the kind of tree which, owing to its fibrous nature, is most suitable for conversion into paper. By two quite different processes is the wood reduced to pulp—by mechanical pressure and friction on the one hand, by the action of sulphide of lime on the other. These two species of pulp, known respectively as mechanical and chemical pulp, have to be commingled together in the process of manufacture. The chemical pulp it is which yields to paper its strength, while to the mechanical pulp it owes its substance and bulk ; and paper made of wood-pulp unmixed with any other material depends for its quality upon the proportion which the chemical bears to the mechanical pulp.

To convey some idea of the process by which the pulp is converted into printing paper I cannot do better than give my impressions of a recent visit to the Sittingbourne mills of Messrs. Edward Lloyd, Limited, whose courteous manager could not conceal a justifiable pride in the splendid machinery which has, so to speak, grown up under his supervision. These mills, which turn out from forty to fifty thousand tons of paper in the year, mainly, though not exclusively, for newspapers, are the largest in Europe ; in size and output, indeed, they have but two rivals in the whole world, and them we must seek in the United States, the land where everything runs big.



THE PAPER MACHINE, CROXLEY MILLS. THE OVAL PICTURE SHOWS THE "WET END" AT WHICH THE PULP ENTERS, THE WHITE FLAT SURFACE BEING THE ENDLESS WIRE-NETTING (p. 144). THE LOWER PICTURE GIVES AN IDEA OF THE SIZE OF THE MACHINE THROUGH WHICH THE PULP PASSES AND BECOMES PAPER.

For the manufacture of the wood-pulp Messrs. Lloyd have mills of their own at Honefos, in Norway, no great distance from Christiania. Having been cut down, the trees are flung into the river above the Hönefos Falls, and in this inexpensive fashion are

borne down-stream to the mills, where they are converted into pulp at the rate of 30,000 tons (of pulp) a year. Large as it is, this quantity is not sufficient to feed the voracious machines at Sittingbourne, and the supply has to be supplemented from Canada.

Whether they come from Norway or across the Atlantic, the bales, weighing about four hundredweight each, are unshipped at Queenborough and brought up the Medway in lighters or sailing-barges to the wharves at Sittingbourne and there stored in huge sheds, to be used in the order in which they are deposited, for the pulp, though it does not quickly deteriorate, will not keep in first-class condition indefinitely. Its treatment at Sittingbourne begins on the "beating" floor, high up in the mills, where it is discharged into large vats in which revolve circular "beaters" that flog out the tiny fibres and gradually, with the help of water, reduce it to what looks not unlike oatmeal gruel. At a certain stage in the "beating" process an aniline dye is poured into the vat in order to whiten the pulp; and afterwards size is introduced, to give cohesiveness to the pulp. Having been brought to the right consistency, the pulp flows into chests, where it is kept in constant motion, so that the heavier fibres—those from the mechanical pulp—shall not sink to the bottom. Then, having been refined and clarified by strainers, which remove from it every foreign substance, it is discharged into machines on the floor below, which it enters at one end, known as "the wet end," in the form of a sheet of water, and leaves at the other end as paper ready for the printing press.

Truly wonderful contrivances are these paper-making machines, and as you see the running stream of water that holds the minute fibres transformed in a few swift transitions into perfectly developed paper, you can hardly help crediting them with magical properties. First the stream of water—in which, if you take up a little of it in the hollow of your hand, you can see the fibres, not much bigger than the motes in a sunbeam, in suspension—runs on to an endless sheet of brass wire-netting, of which the meshes are almost inconceivably small, there being as many as 400 holes to the square inch. This wire, in carrying the pulp forward, jogs from side to side, so as to shake the fibres together. On each side of the wire-netting is an endless band of rubber

PAPER MACHINE ROOM, OLD MILL, SITTINGBOURNE.

PAPER SORTING HOUSE, CROXLEY MILLS. *Photo. F. Downer & Son, Watford.*

which travels with the netting, and prevents the pulp from running over the sides. Before it leaves the wire the pulp passes over a series of suction-boxes, and by the time it has run the gauntlet of these it has acquired a measure of cohesion and continuity: already is it easier to believe that what a moment ago looked like a thin stream of water will before this wonder-working machine has had much more to do with it be changed into paper.

When the pulp leaves the wire-netting it is carried on to the first of a series of rolls. This first pair of cylinders is known as the couch-rolls, and in passing between them most of the moisture which has not been extracted by the suction-boxes is squeezed out of it. Then it is carried on to press rolls, which squeeze out more and more of the moisture until at last the pulp is indubitably paper. Not yet, however, is its conversion complete. Still it moves on, for it has now to be dried by passing round steam-heated cylinders. This done, it is carried on to the calenders—metal cylinders with a smooth, polished surface, which by subjecting it to tremendous pressure give to its surface smoothness and gloss. Then the edges are trimmed and it is divided into the required widths, and finally it is wound on to reels, the length of the roll being automatically registered. When the indicator shows that the roll is of the required length, the paper is at length separated from the machine to which it owes its being, the reel is weighed, and then it is ready for delivery to the printer. That the paper should be weighed as well as measured may seem a work of supererogation, but of course it is nothing of the kind. The fact is that, nearly as these beautiful machines approach to perfection, rolls of paper of precisely the same length may differ a few pounds in weight, owing to variations in the pulp too slight for even this delicate machinery to recognise and correct.

Of the two great driving-engines, with their enormous fly-wheels, of the twenty-two Galloway boilers with their hoppers for automatic stoking, and of the other wonders of these mills I may not speak. I must, however, just touch on one point that has not yet been mentioned. Nothing is more striking than the way in which everything in the nature of waste is avoided. Thus by a system of pipes spent heat is utilised on a scale that has resulted in a saving of not far short of £100 a week in the coal bill; and in the same way the waste water is not allowed to escape until all the pulp which it contains has been yielded up in the form of thick slabs, which are consigned to the beating vats to be reduced once more to the oatmeal gruel of which I have spoken.

The tint which distinguishes certain editions of the cheap evening papers is imparted by pouring a little dye into the vats. But if you visit one of the mills where coloured papers proper are made, for writing and various other purposes, you find that the effect is secured not by any such simple means as this, but by thoroughly dyeing the rags before they are disintegrated. I must note, too, that the high gloss that is given to paper upon which "process" illustrations have to be printed is obtained by the process of super-calendering, the paper being run through special calendering machines after the paper-making machine has finished with it. The best paper of this class—as, for example, that which is used for BRITAIN AT WORK—undergoes the further process of "coating," one of the latest and most interesting of paper-making operations. But this, with much else that merits notice, I must leave undescribed.

W. W. HUTCHINGS.

READY FOR USE. A BIG STORE OF PAPER AT THE SITTINGBOURNE MILLS.

OMNIBUS AND TRAMWAY TRAFFIC.

THE Omnibus and the Tram are so much commonplaces of city life that one is apt to overlook the magnitude of the interests they represent.

The capital sunk in Metropolitan street-car enterprises is, in round numbers, four millions sterling. This enormous sum is productive of profit, directly or indirectly, to incalculable thousands, besides providing for the hourly convenience of five millions of Londoners. It excites, as it were, a great economic wave, whose influence is felt not only in the labour market of the capital, but likewise in Canada, the United States, Hungary and Russia, and last, but by no means least, in Ireland.

A VETERINARY SURGEON EXAMINING HORSES.

The various companies have in their possession about forty thousand horses, valued at over a million sterling. A huge fraction of their revenue flows annually into the pockets of Irish and Hungarian horse-breeders to replenish the waste in horse-flesh. And more than twice the amount goes to North and South America, and Russia, to buy oats, maize, barley, beans, hay and straw, for the gigantic granaries from which the studs, scattered all over London, draw their allowances of provender. This is how one form of a London enterprise affects the world's marts. The advantages to London itself are less easily summarised. But one statement of fact is eloquent in its simplicity. Upwards of thirty thousand men are engaged in the street transit services, which, allowing for a moderate percentage of married people, means that seventy thousand persons are dependent for their daily bread upon the prosperity of the industry.

The London General Omnibus Company, employing seventeen thousand horses and five thousand men, is probably the greatest institution of its kind in the world. The wages account for its drivers and conductors totals up to over £300,000 in the course of a twelvemonth, leaving an army of superintendents, inspectors, timekeepers, lampmen, cleaners, stablemen, artisans and clerks, still to be provided for. In alliance with the London General are numerous omnibus associations. The Road Car Company, with only five thousand horses, manages to maintain a spirited competition with the premier concern and its allies. In eighteen months the London General carries passengers equivalent to the population of all Europe, or, in round numbers, three hundred millions. During a similar period the Road Car accommodates a number represented by the population of all North America, or roughly, a hundred millions. How insignificant the population of London appears when set in contrast with these bewildering figures! And all these millions are piled one upon another by the daily coming and going of

individuals. Yet they are not exhaustive. The omnibuses owned by Tilling's, French's, Bull's, Ball's, and many smaller firms, must carry in the aggregate many additional millions of passengers annually. If by any chance its street-cars ceased to run even for a day London would, in fact, seem stricken with paralysis. The shops in the West, the warehouses in the East, the offices in the City, would all feel the ominous torpor. And the Riverside, from Woolwich to Battersea, usually alive with ten thousand signs of commercial activity, would bear gloomy testimony to the close relationship between the hum of trade and cheap street transit.

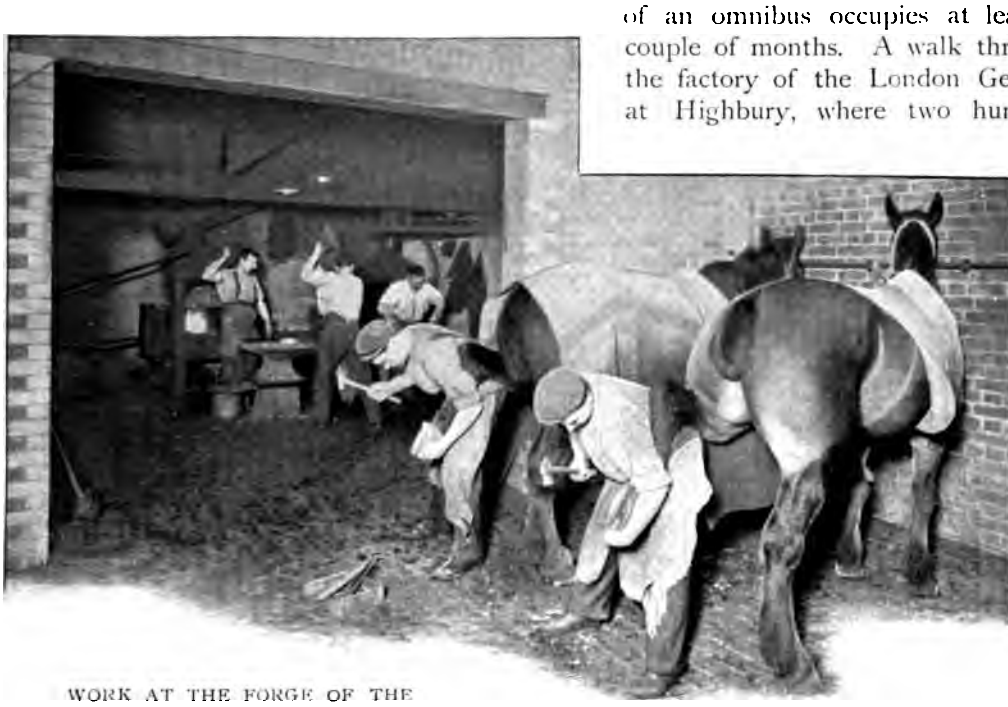
THE FORAGE DEPÔT OF THE LONDON GENERAL OMNIBUS CO., BROMLEY.

The London Tramway service is practically monopolised by the North Metropolitan Company and the County Council. The lines south of the Thames are worked mainly by the Council, and as a rule converge upon the Bridges. North of the River is the province of the North Metropolitan, and its lines run generally Citywards. It links such distant points as Lea Bridge and Bloomsbury, Stamford Hill and Holborn. Moorgate Street, where the offices of the North Metropolitan are situated, is a leading terminus, being connected with Highgate and Finsbury Park by a route which taps a densely populated district. To the battalions of labourers, by whose sweat London throbs throughout the weary night, the trams are a priceless boon, for they run without intermission during the whole twenty-four hours. The North Metropolitan Company employ eight thousand horses and four thousand men; the County Council only half that number of horses to three thousand men. The North Metropolitan require six hundred cars; the County Council maintain a continuous night and day service with two hundred less.

THE LONDON GENERAL OMNIBUS COMPANY'S STABLES AT HOLLOWAY.

The London County

Council's Tramway system is probably the most self-contained to be found anywhere. It builds its own vehicles at Penrose Street, Walworth Road; makes its own harness; prints its own tickets; and even manufactures its own punches. As in the case of the private companies, provision has to be made for maintaining a continuous supply of enormous quantities of forage. No less than one-half of the hundred odd millions of passengers who use the Council's trams in the course of a year are halfpenny fares. An immense proportion of this number are women of the working class, going to the cheapest markets to do their shopping. The municipal tramway employees receive from 4s. 9d. to 6s. 3d. a day, a rate of wages which is somewhat higher than that usually paid by the private companies. Very well paid men amongst the legion engaged in the street-passenger traffic, are those in the service of the Waterloo and Atlas Omnibus Association, which is affiliated to the London General, their wages ranging from 6s. to 8s. a day. A number of small tramway companies still survive the efforts of the two principal proprietors at amalgamation. These include the South London, the London Southern, the London Deptford and Greenwich, and the Highgate "cable" line, employing between them about a thousand men. In the United Kingdom there are thirteen hundred miles of street tramway open. Of these, one hundred and forty are claimed by London, sixty-three being in the hands of the North Metropolitan.



WORK AT THE FORGE OF THE ROAD CAR COMPANY.

The building of street-cars for the various companies is an industry of very great importance, and is steadily growing. The North Metropolitan Tramway Company has its factory at Leytonstone, where cars are turned out at a cost of about £200 each, twenty cars being a fair year's output. The construction of an omnibus occupies at least a couple of months. A walk through the factory of the London General at Highbury, where two hundred artisans are kept busy, is full of interest. The department in which the work commences is distinguished by the ghoulish name of the "Body-shop." The Body-shop is appropriately full of skeletons, some of which are omnibuses in shape, but lacking paint, and glass, and staircase, while others are merely four bare planks. Here one realises, with just a touch of surprise perhaps, what diversity of skill the production of a street-car calls into action. When the coachbuilder has completed the hull, it is mounted on temporary wheels, and passes successively through the hands of the glass-fitter, the upholsterer, the smith, and the painter. Next-door to the

Body-shop is the Repairing Department. In days gone by an omnibus lasted twenty years; now, at the end of fifteen, it is only fit for firewood. The change is due to the tendency to turn out showy, lightly built vehicles, which shall be as attractive as possible. The coachbuilders and the allied trades reap the benefit of this evolution in fashion in the form of increased demand for their labour. The painter especially plays an important part in the finishing of the modern street-car. His work may not always be artistic. But it means bread to scores of families—to thousands, when one comes to reflect that the Paint-shop at Highbury is but a type of many hundreds in England alone. Painted on the corner of each omnibus are a couple of letters that are always a puzzle to the layman. Take the mystic symbols "Q M." These characters indicate that the car belongs to "Q" district—every company's territory is cut up into districts—and "M" denotes its order of rotation with regard to all the other cars on the same route. When a London street-car leaves the factory its first journey is to a police-station, where the christening ceremony is performed. No champagne flows over its timbers. Instead, a constable screws on to its platform a number surmounted by the Royal arms.


SACKING FORAGE AT TILLING'S.

The Express omnibuses are a survival of the days when the poor man did little driving; and they are still chiefly availed of by well-to-do business men. They are drawn by three horses, after the manner of Mr. Shillibeer's omnibuses of the early Victorian period, and carry thirty-eight passengers, which is twelve more than the usual complement. They run only in the morning, the chief points of departure being Holloway, Tollington Park, Kilburn and St. John's Wood. A new Express has not been built for a long time, and now that ordinary cars are so numerous the class seems doomed to extinction.

The advertising business done by the Metropolitan Omnibus and Tramway Companies is worth considerably more than £100,000 a year. The annual income of the London General alone, from this source, reaches £40,000. If this branch of revenue were from any cause to be withdrawn from the poorer companies, the consequences to them would be simply disastrous.

It is rather a reversal of the natural order of things that places like Hull and Coventry should have excellent systems of electric traction, while the Londoner must travel as far afield as Shepherd's Bush to see an electric car. Comparison in this respect with any of the great cities of Europe, or America, is entirely unfavourable to London. The New York electric tramways are the most pretentious in the world. Money has been poured out on them with a prodigal hand. And as much more would be promptly expended if only Science yielded up some new and potent secret which the engineers could utilise to better purpose than electricity. The electrical "conduit" principle is that upon which the leading New York lines are constructed. The advantage of this method is that the appearance of the streets is not impaired, as the electric current is conducted through an underground wire. Blackpool was the first town in the United Kingdom to avail itself of the "conduit" plan. Occasionally, however, the washing over of the tide overlays that portion of the line on the sea-front with sand, causing some inconvenience; but otherwise the enterprise has been rewarded with success. Perhaps the

THE BUILDING SHOP OF THE LONDON GENERAL OMNIBUS COMPANY.

OMNIBUSES AT PICCADILLY CIRCUS.

GLASGOW CORPORATION TRAM.

only tramway in the world which refuses advertisements runs through the Andrassy-Strasse, Buda-Pesth. This, however, is not its only peculiarity. As the municipal authorities would not under any circumstances tolerate an ordinary tramway, the promoters had to construct a subway just beneath the surface of the street. There are three miles of double rails, and eleven stations approached by stairs from the footpath. The work is a splendid piece of engineering, which meets satisfactorily the requirements of pedestrian traffic while also preserving the beauty of the city. So admirably has the scheme worked that it has been adopted in the busiest district of Boston, with characteristic American modifications. Glasgow has possibly the finest service of trams in the United Kingdom; and about four hundred cars are in regular use. Edinburgh, for æsthetic reasons, adopted what is known as the "cable" system. The Scottish capital is quite pleased with its service, but, considering the steady progress of electrical invention, the prudence of its policy in this particular seems highly problematical. Dublin, Manchester, Nottingham, Middlesbrough, Belfast and Cork, to select a few places at random, are all more up-

A SHEPHERD'S BUSH TRAM.

A LONDON COUNTY COUNCIL TRAM: THE RUSH FOR SEATS.

to-date than London. The overhead wire or "trolley" system is the one which has been generally adopted in England and on the Continent. Its distinctive feature is that iron posts are required to support overhead wires; and these are of necessity out of harmony with the appearance of a really handsome thoroughfare. Merrion Square, Dublin, for example, with its noble mansions and delightful old gardens, has not been improved by their

introduction. It was to avoid such transgressions against taste that the Edinburgh Corporation refused to have anything to do with the "trolley" system.

The march of knowledge is so swift—there is always some danger that a new discovery may render old-fashioned to-morrow what yesterday bore the hall-mark of Progress. Not long ago, however, the London County Council agreed that this very reasonable fear should not any longer deter them from deciding how the Metropolitan street-car system could be improved. After a painstaking investigation by the Council's representatives of what had been done, and was being done, in Europe and America, it was resolved to follow the example of New York, and have the London tramway system reconstructed on the "conduit" electric principle. The revolution will be effected very gradually.


ELECTRIC TRAM AT HULL.

But within the next few years the old style shall have completely given way to the new; and the horseless carriage will be the popular mode of street locomotion throughout the Metropolis.

P. F. WILLIAM RYAN.

A FAMILIAR SCENE IN LONDON: POLICEMAN REGULATING THE TRAFFIC.

SAWING LOGS FOR CHAIR LEGS.

A CHAIR-MAKING TOWN.

THE chair plays such an important part in our modern social economy that it is difficult for us to imagine a chairless state of society. Though Orientals may be content to squat or recline upon the ground, we feel that it would be impossible to support the dignity of our Western civilisation without chairs. A throne, which is but a glorified chair, is the symbol of the most exalted rank; to invite a man to take *the* chair is to pay him a recognised compliment, and to invest him, for the time being, with almost despotic authority over some section of his fellows; while the offer of *a* chair is one of the commonest forms of conventional politeness.

There is one district in England where the demand of the civilised world for chairs is being met in a very effective manner, and under conditions that are probably unique. At High Wycombe, and in the villages surrounding it, the one aim of the population seems to be to produce chairs in endless variety and almost unlimited quantity. Amsterdam is said to be built upon herring-bones, and with at least equal truth High Wycombe may be said to be built upon chairs.

For generations past the youth of this part of Buckinghamshire have been brought up as a matter of course to take some share in converting the beech, ash, and elm trees of their native woods into chairs, just as the boys of a mining district almost inevitably become miners.

Within recent years the industry has increased enormously, stimulated by the introduction of machinery and the importation of foreign timber. One result of this growth is the curious one that the casual visitor is likely to be less struck with the extent of the trade than he was formerly. In the earlier days of the industry nearly every inhabitant of the town was a chair-maker, and nearly every cottage was a workshop. The visitor walking through the town on a summer day would see through the open door of each cottage the occupier at work at his bench or lathe, while stacks of chairs or parts of chairs stood around, and the women, and often the children, sat at the door caning or rushing the chair seats.

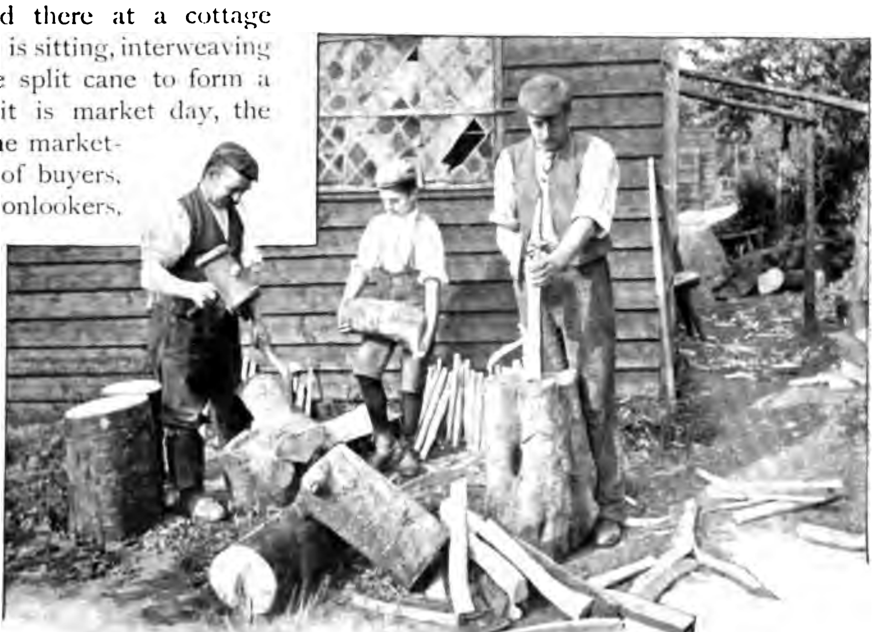
To-day the great majority of the men are engaged in factories, some of which employ as many as 300 hands, while others are quite small; the women are occupied in domestic duties in the trim little red brick cottages, from which, as a rule, all signs of the owners' occupation are banished; and the children are being looked after by the School Board. The well-to-do manufacturers live in pleasant villas on the hills surrounding the town, and to meet the needs of the large industrial population there is, of course, a considerable trading community. The town, therefore, now presents at first sight much the same appearance as any other country town of similar size.

Yet even to-day the observant visitor cannot fail to detect signs of the exceptional and distinctive character of the place. In the station yard are great stacks of "dimensioned wood," just delivered from Canada—that is to say, parts of chairs cut to standard sizes, and needing only to be jointed together and stained or varnished; loads of chairs are being despatched by rail, and waggons, on which the chairs are piled up to a great height, are leaving the town by road for London · chair frames are being taken from the factories to the cottages, for the cottage industry is not wholly extinct, or the completed chairs are being delivered at the factories. Here and there at a cottage door a woman or girl is sitting, interweaving with deft fingers the split cane to form a chair seat; and, if it is market day, the visitor may see in the market-place a little crowd of buyers, or merely curious onlookers, gathered round a voluble gentleman, who, with the aid of a loud voice, a facetious manner, and a notebook, is selling small quantities of timber by auction.

Few manufacturing towns are so pleasantly situated as High Wycombe. It lies in a beautiful valley, flanked by beech-clad hills; down the valley flows a shallow stream, which wanders through the streets of the town, adding to its picturesqueness, and affording fine opportunities for sport to juvenile anglers. If we pass through the town and continue along the Oxford road for a couple of miles we come to West Wycombe, a charming old village, which contains one old-established factory, a single street of delightfully quaint houses, and a church, which is quite a curiosity owing to its extraordinary mixture of architectural styles.

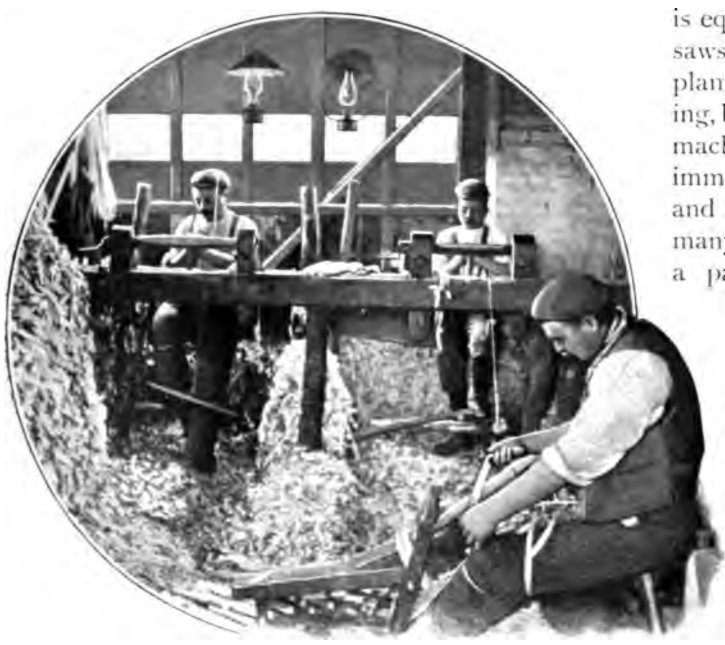
It has been estimated that the output of chairs from Wycombe amounts to seven or eight for every minute of the day and night; in other words, Wycombe supplies in the course of a year the equivalent of a chair apiece for every man, woman, and child in London. When occasion requires, some of the Wycombe firms can turn out chairs with astonishing rapidity; 5,000 chairs were made for the Alexandra Palace in six days, and 19,000 were made and delivered in London in a few weeks for use at Messrs. Moody and Sankey's revival meetings.

Scarcely less striking than the quantity of the chairs produced is the variety of their patterns. These are numbered by thousands, and are constantly being added to. It is



SPLITTING LOGS FOR CHAIR LEGS.

astonishing to find, when one begins to investigate the subject, how wide is the scope for the artistic designer in respect to so simple an article as a chair. Chairs are like ladies' hats, there seems to be no limit to their possible variations; and if at times the novelties verge on the grotesque, or the designer seems to have forgotten that a chair is intended to be sat upon, there are nevertheless always to be seen in the Wycombe workshops new patterns that are both artistic and convenient, as well as plentiful reproductions of the old and approved forms. From the state chair of the mayor, with its rich upholstery and elaborate carving, down to the humble "Windsor" chair, which has always been the staple product of the Wycombe trade, every imaginable variety of chair may be seen in process of manufacture in the Wycombe factories.



TURNING CHAIR LEGS IN A COTTAGE.

Nor is it chairs alone that occupy the attention of the Wycombe manufacturers. Of late years several firms have added to their business other branches of the furnishing and cabinet-making trades, and some of the handsomest sideboards and the daintiest cabinets to be seen in Tottenham Court Road were made at High Wycombe.

To see the newest methods of furniture production in operation, we cannot do better than pay a visit to the factories of Messrs. W. Birch, Limited, one of the oldest and largest firms in the town. Very interesting is it to watch the progress, say, of a beautifully inlaid drawing-room chair from the rough timber stage through the various processes of moulding, inlaying, framing, polishing, and upholstering. Probably the most fascinating department to most visitors would be the Machinery-room, which is equipped with circular saws, frame saws, band saws, and fret saws; planing, moulding, mortising, tenoning, boring, turning, and sand-papering machines. With the aid of these an immense amount of labour is saved, and it would be a revelation to many persons to see how important a part machinery may play in the production even of high-class furniture.

It is inevitable, and no doubt on the whole beneficial, that in furniture making, as in other trades, machinery should be taking the place of hand labour. But, watching the wonderful machines performing their various functions with dead accuracy, and apparently with little exercise of skill on the workman's part, one cannot but feel that the new conditions must tend to the decay of artistic taste and skilful craftsmanship. There is, of course, scope for these qualities in the designing of new patterns—with which, however, the workman has nothing to do—and in the blending of the beautifully coloured woods to form elaborate inlaid patterns; but, on the whole, the conditions of modern industry seem unfavourable to the development of great artist-craftsmen like Chippendale, Sheraton, and Hepplewhite. Happily, there seems to be a desire in the town to develop, as far as may be, the artistic capacity of the young people. A school of art has been established for several years, and is well attended by workers in the furniture trade, who find the instruction in wood-carving specially valuable.

From the economic point of view it is hardly disputable that the machinery, which is now so generally adopted, has proved a boon to the worker as well as to his employer. The trade of the town has so enormously increased that, notwithstanding the numerous labour-saving devices, the number of men employed is far greater than in the days when everything was done by hand. The population of the town, which is now a little over 20,000, has doubled within the last thirty years—a sure sign of the growth of the town's staple industry. Under the old system piece-work was universal, and employment was very irregular, but in the modern factories payment is almost invariably by the hour, and the great majority of the workers are assured of regular and continuous employment. Then, again, wages are much higher than they were a generation ago.


MACHINE ROOM.

It must not be supposed that up-to-date methods have entirely superseded the old cottage industry. It still survives in the outlying districts, but is confined to one or two branches of the trade—namely, the caning and rushing of chair seats and the turning of legs and spindles. Our illustration shows one of these cottages in which the last-named work is being carried on. The cottage is fitted with the old-fashioned pole lathe, and its present occupant carries on the work under much the same conditions as his father and grandfather did before him. Most of these small traders keep a pony and cart, and when they have a good stock of parts turned up to certain standard sizes they take them into town and sell them to the large manufacturers.

There is one delightful form of the industry which belongs, unfortunately, to the past. Some of the men, in order to save the labour of carting the timber to their workshops used to go out to the woods and improvise with a screen of boughs a truly Arcadian workshop. Here, just where the trees were felled, they would cut them up into billets of various sizes, which they would shape on the spot into chair legs and backs.

But though the wanderer in the neighbourhood of High Wycombe to-day is not likely to stumble upon one of these sylvan workshops, he may well regard the lot of the worker in his thatched cottage, amidst the beautiful surroundings of the Buckinghamshire hills and woods, as in many respects an enviable one. And even in the factories in town the conditions under which the work is carried on are many degrees better and

FRAMING ROOM.

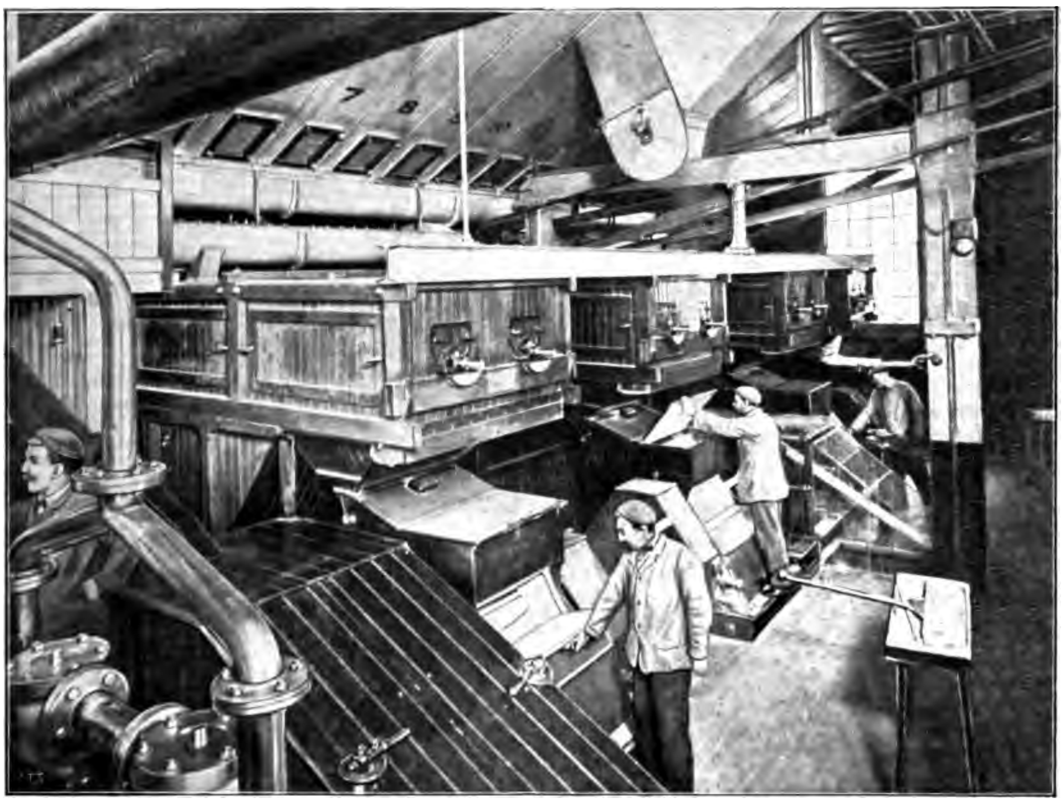
healthier than those which obtain in the neighbourhood of Curtain Road, the centre of the London furniture trade. At Wycombe the men may work in the sunlight, within sight of the wooded slopes of the Buckinghamshire hills, and within sound of innumerable singing birds, while in their homes there is no lack of "room to live," for each family has its own cottage, and each cottage its strip of garden. And the Buckinghamshire chair-maker pays no more for his cottage and garden than the London workman often does for a single room. Work is fairly regular, but should trade be very slack the workman can often tide over the hard times by getting a job at a neighbouring farm. In view of these comparatively favourable conditions, it is not surprising that many London workmen who have wandered to High Wycombe in search of work should have settled down permanently in the town.

HUGH B. PHILPOTT.

ON THE ROAD TO LONDON.

BEER-MAKING.

THE vastness and importance of the brewing interest in the British Isles is shown by the fact that the revenue derived from beer in a recent year was more than £13,000,000. The duty is fixed at seven shillings and ninepence on a barrel of 36 gallons of a certain strength, which is termed the standard specific gravity. This standard of strength on which the duty on a barrel amounts to seven shillings and ninepence may be taken as being the ordinary strength of mild ale. The duty, therefore, on pale ale, stout, and strong ale is proportionately more on each barrel. An idea of the relative strength of beers may be easily gained by a comparison of the different quantities of malt used in their manufacture. One quarter (which equals eight bushels) of malt will make four barrels of mild ale, but only two of strong ale, and the quantity used in pale ales and stout varies between these. The duty is collected by Excise officers, who supervise every brewery.



THE MALT ROOM, MESSRS. WHITBREAD'S BREWERY.

THE FIGURES 7, 8, 9, 10, 11 AND 12 ARE NUMBERS OF HOPPERS THROUGH WHICH MALT FALLS INTO MILL; THE SMALL SQUARES UNDER FIGURES ARE OF GLASS, SO THAT IT CAN BE SEEN WHEN THEY ARE EMPTY.

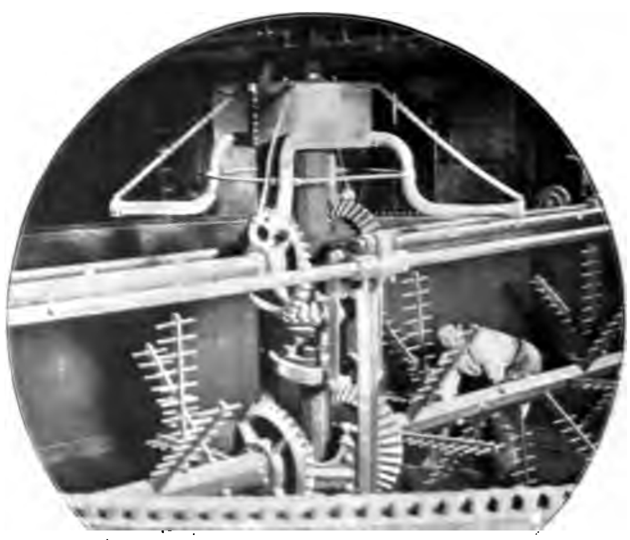
Beer being an article of daily consumption, of a bulk out of all comparison to the ingredients required, it follows that the place of manufacture, or the brewery, is as a matter of economy always in the centre of the densest population. The principal exception is Burton-on-Trent, and in a lesser degree Dublin and London. The fame of the brewing qualities of the Burton water dates from the thirteenth century, when the discovery was made by the monks of Wetmore. The peculiarity of the Burton water is an almost entire absence of carbonate of soda and sulphate of soda, so

EXTERIOR OF MASH TUN (MESSRS. BARCLAY, PERKINS AND CO.'S BREWERY).

millions sterling. A large proportion, however, of the capital of a brewery company is invested in public-houses by way of loan to the tenant, or purchase of the freehold, thus securing the custom of the house for beer. This system of tied houses was to an extent forced on the brewers by public opinion being not only averse to the granting of new public-house licences, but showing a tendency to demand a reduction of those already existing. The brewers quickly recognised that a licence had become not only a valuable asset, but a modified monopoly, and they each secured as many as possible to "tie" a trade for their respective breweries. At the present time the number of "free houses," or public-houses which are under no obligation to buy beer from a particular brewery, are under ten per cent. of the total number of licences; there is thus little scope for further expansion among existing breweries, and practically no opening

largely present in London deep well water. It also has present a high percentage of sulphate of lime, which makes a hard water eminently adaptable for brewing a light, delicate beer. The water of Dublin and London has much greater extractive qualities than that of Burton, and for that reason is admirably suitable for brewing stout and porter. There is no difference in the processes of brewing light and dark ales, the darker colour of stout being caused by roasted malts being used. Burton is a town entirely given over to the brewing interest. It brews not only for local consumption, or to supply the needs of any particular district, but for the beer-drinking world. The fame of Dublin stout also causes a demand throughout England and the colonies, and London enjoys a considerable export trade, besides an increasing outside bottling trade.

There is hardly a town in England without a brewery, and certainly none with any pretensions to importance. The tendency with breweries, as with most other industries, has within recent years been to amalgamate, which has led to the creation of enormous undertakings with stupendous totals of capital — that of Messrs. Watney, Coombe and Reid, the largest company, being upwards of seventeen



INTERIOR OF MASH TUN (MESSRS. WATNEY'S BREWERY).

THE MECHANISM IS SHEWN STATIONARY. THE MAN IS REMOVING ONE OF THE SLOTTED PLATES THROUGH WHICH LIQUID DRAINS FROM GRAINS.

for a new brewery to start business, as the extent of a brewer's business is practically limited to the number of public-houses he can control. The only exceptions are certain brewers with a family trade, and some of the large firms of world-wide reputation. It is generally understood that Guinness, of Dublin, own no tied houses.

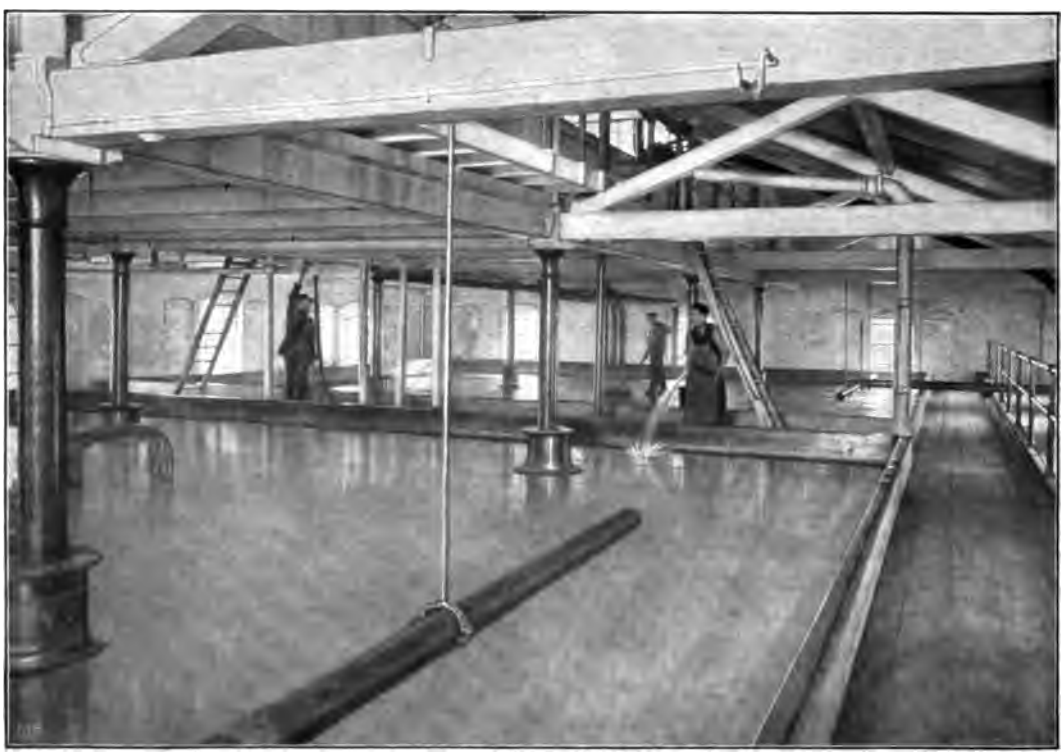
The number of men employed in breweries is enormous, the staff of a small brewery being at least 100, while the average may be taken as from 400 to 700 in the large breweries. Of the total number of men employed on the premises, those actually engaged in the process of beer-making is comparatively small, the reason being that everything in a brewery is done that can be done by machinery, with a view to perfect cleanliness and uniformity in process. The manual workers are mostly cellarmen, yardmen, coopers, draymen, sawyers, carpenters, engineers, farriers, stablemen, bottlers, washers, and labellers. The great attraction of employment in a brewery is that it is permanent. Work is constant the whole year round, few extra hands are ever taken on, and the regular weekly workman can count on fifty-two weeks' wages a year.

THE BIG COPPER (MESSRS. WHITBREAD'S BREWERY).
THIS IS HEATED BY STEAM. APERTURE IS SHOWN THROUGH WHICH HOPS ARE INTRODUCED.

The actual process of making beer has not varied for over two centuries, but the resources of science have led to an almost absolute certainty of result. Beer is an infusion of hot water and crushed malt boiled with hops, and when cold fermented ; but this simple statement implies rapid fluctuations of temperature and intricate chemical changes. The chemical action that takes place is now thoroughly understood, and the changes of temperature controlled by appliances with perfect exactitude. Years ago the motto of the country brewer was "Time corrects the errors of the operators," which led to long and unprofitable storage ; but now the aim of every brewer is to bring his beer quickly into condition for immediate sale. So rapidly is this accomplished, that the contents of Monday's mash tun will be ready for drinking the following Friday. The science and high technical skill the brewer now brings to bear on his calling has been principally developed in the study of natural chemical action and careful analysis of the ingredients and water used. Pasteur, it may be mentioned, carried on the interesting series of experiments which led to his highly important discoveries regarding micro-organisms at Whitbread's Brewery. A minority of brewers have experimented to find substitutes for the time-honoured original materials, accomplishing little of a satisfactory nature, but the majority have chiefly interested themselves in securing the perfect purity of their product by entirely natural methods. In many breweries the sole ingredients used are malt and hops, and in others, where invert sugar is added, it is not from any motive of economy, but to make the beer drinkable quicker. The present cheapness of hops has rendered adulteration quite unnecessary,

THE COPPER STAGE AT MESSRS. BARCLAY'S BREWERY.

THESE ARE HEATED BY FURNACES BURNING ANTHRACITE COAL. THE HOP POCKETS CONTAIN $1\frac{1}{2}$ CWT.



THE COOLING LOFT AT MESSRS. BARCLAY'S BREWERY.

THIS CONTAINS TWO COPPER COOLERS 16 INCHES DEEP.

even to those smaller brewers that at one time may have used substitutes; but as regards the large and well-known breweries, nothing but malt and hops—and sometimes sugar—is ever used. The price of hops varies greatly, according to the quality and amount of the crop. It may be as high as four shillings a pound, or as low as sixpence, the latter being about the present price. This value is not expected to fluctuate so much in the future, as the cold storage of hops is being introduced, it being found that at a temperature of from 25° to 28° Fahrenheit they will keep for years. The price of malt is more stable, the average quotation being about forty shillings a quarter.

Ale is known by three definitions according to its strength — mild, pale, and strong. Brown beer, when of similar strength to mild ale, is known as porter, and when equal to pale ale or bitter as stout. The quantity of hops used varies according to the quality and class of beer to be brewed. It may be as low as 6 lb a barrel for mild ale, or as high as 18 lb. a barrel for strong ale.

Beer-making commences with cleaning and crushing the malt, which is the chief ingredient and factor in beer-making. Malt may be produced from any of the cereals by process of germination stopped at appropriate stages, but barley is the only grain which combines in itself all the requisites for the production of a perfect malt. The barley is, after being steeped in water to induce germination, turned on floors to allow development of the acrospire and to prevent the undergrowth of rootlets; when the acrospire is two-thirds up the back of the grain the vegetation is arrested, and the barley allowed to wither previous to passing to the kiln for drying. This is first effected at a low temperature to freely evaporate the moisture, but gradually rising to 200° Fahr. In the country the maltings are frequently an adjunct to the brewery, but in London the malt is delivered at the brewery in sacks. It is stored in bins of enormous capacity on the top floors, being conveyed there by machinery. From the bins it falls by gravitation through hoppers into the mills, to be cleaned from dust by being passed over revolving graded screens, and then crushed by rollers to the fineness desired for the malt liquor to be produced. It is also passed between magnets, which arrest any particles of metal which might be present. Below these mills the mash tuns are usually to be found, and here the malt is mixed with hot water. These tuns are simply circular

CLEANING OUT INTERIOR OF FERMENTING VAT (MESSRS. BARCLAY'S BREWERY).

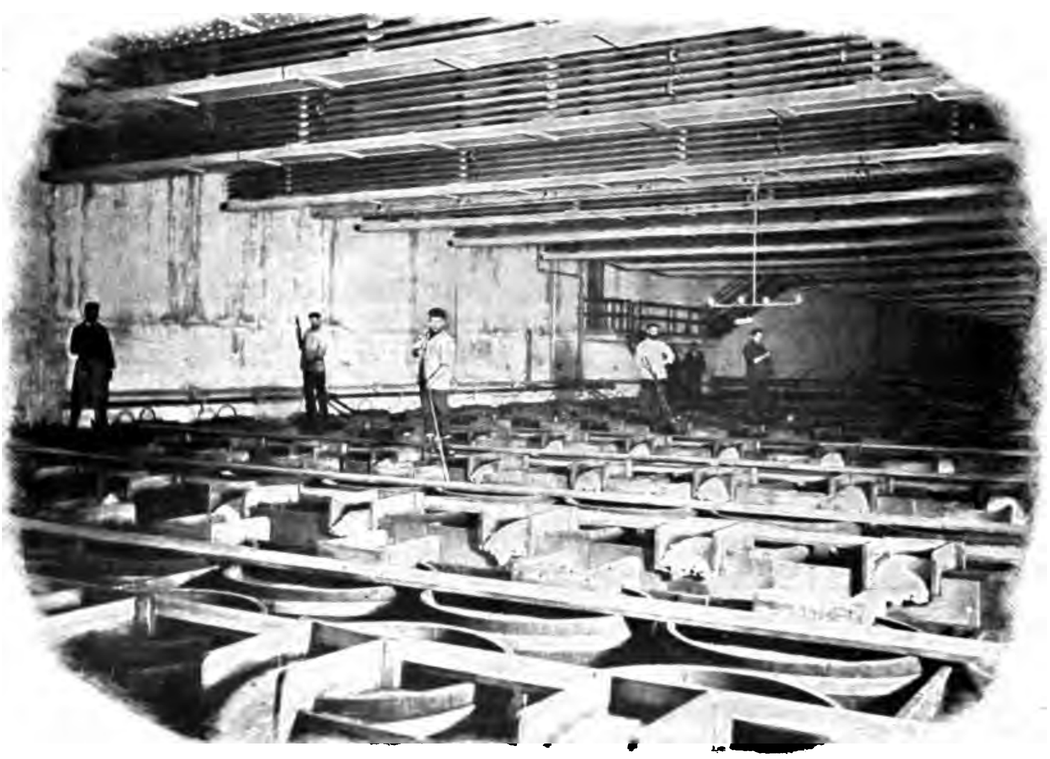
THE ACTUAL HEIGHT OF VAT IS TO THE TOP OF LADDER; ABOVE IS SUPERSTRUCTURE TO CONFINE THE YEAST WHEN RISING. THE PIPES IN CENTRE ARE THE ATTEMPERATORS.

vessels fitted with covers and certain interior machinery. They also have facilities above for the introduction of the hot liquor or water and the malt, and below for straining away the malt extract or wort. The interior machinery is two-fold, each used for the separate processes to which the malt is subjected. The first is called mashing, and continues for about two and a half hours, during which the malt is continuously stirred by rotating rakes, thoroughly mixing it with the hot liquor, which will then contain a large proportion of malt extract, and is called wort. This, when at its proper density, is drawn off from the mash tun into vessels called "underbacks," from them pumped to the "copper-

MEN SKIMMING VATS (MESSRS. TRUMAN, HANBURY, BUXTON AND CO.'S BREWERY).
IN THE TWO TANKS IN FOREGROUND MEN ARE SEEN WITH SURFACE BOARDS PUSHING THE YEAST TOWARDS OPEN MOUTH OF PARACHUTE.

backs," and thence run into the copper, where the hops are added and the whole contents boiled.

At the bottom of the mash tuns are fitted a number of slotted plates, which, while allowing the wort to run off, retain the malt in the tun. This malt has as yet parted with only a proportion of its fermentable matter, and is now subjected to the process of "sparging." This consists in sprinkling the surface of the malt as it lies in the mash tun with hot liquor by means of slowly revolving sparging arms, which are simply perforated pipes through which the



THE PONTO ROOM (MESSRS. WATNEY'S BREWERY).
YEAST IS SEEN RISING THROUGH APERTURE IN PONTO AND FALLING DOWN OPEN SIDE.

liquor slowly falls. This process continues for about five hours, and is termed "sparging." The resulting second wort is dealt with in the same way as the first, and the spent grains are used for cattle food. The "backs" mentioned are large vessels into which the wort is drawn as a matter of convenience before proceeding with the next process. Thus the vessel below the mash tun into which the wort drains is called an underback. From here it is pumped to the copper back, which is placed on a higher level than the copper, so that the wort may readily flow into the copper when required. The coppers have, as might be expected, an enormous capacity, some holding upwards of 900 barrels. They vary, however, in the method of heating, some having furnaces and others using steam. Where furnaces are employed, anthracite coal is most generally used. It is claimed for the system of steam heating that it is more easy to regulate. All boilers are now fitted with a simple interior contrivance which obviates the possibility of boiling over. After the wort has been boiled it is run into "hop backs," which are also fitted with a false bottom of slotted plates, which allow the liquid to drain through but arrest the hops. The wort is then pumped up to the cooling loft, and the hops returned to the copper to be boiled with a fresh supply of wort.

The cooling loft invariably has large open apertures or louvres on all sides, and a heavy roof to prevent the heat of the sun from being felt. It is built so that the atmosphere freely enters and passes over the coolers, which are shallow vessels about 16 inches in depth, occupying the entire floor space. On the floor below the cooling loft are to be found the refrigerators, which consist of a series of brass tubes through which cold water is pumped. The wort passes over these, and is then at a proper temperature to pass into the fermenting vessels, where the yeast is added and it becomes beer.

These fermenting vessels are of varied shape, but more frequently square, and consist of a solid body to hold the liquid, and a light superstructure of movable battens to retain the froth thrown up by the yeast from overflowing. Inside they are fitted with a series of pipes called attemperators, through which cold water is pumped. By this means the required temperature is maintained, quickening or retarding fermentation as desired. The chemical action of fermentation produces carbonic acid gas and alcohol; the gas is for the most part got rid of, but the latter remains. It is in the process of fermentation that the critical stage of beer-making is reached, for the nose, palate, and brightness of the beer depend on the yeast, which is added to the extent of one pound per barrel. Working satisfactorily, the yeast in rising assumes various fantastic forms and shapes, but the brewer views with the greatest satisfaction a billowy rising and a rocky head. In the earlier stages of fermentation the froth rises to a great height, sometimes overflowing the lofty superstructure of the

RACKING MACHINE (MESSRS. WATNEY'S BREWERY).

AS CASK BECOMES FULL ANY OVERFLOW RUNS BACK THROUGH SMALL PIPE UNDERNEATH MAIN PIPE INTO TROUGH.

fermenting vessel, but it finally subsides, forming a thick cream. When the fermentation is completed all that remains is to cleanse the beer from the yeast, which has in the process increased by fourfold the amount originally added to the wort. This is effected variously, but each process takes advantage of the natural tendency of the yeast to rise above the beer. The method most generally in use in London is by skimming machines. These are large oblong vats having across the centre from side to side what is termed a parachute. This has a wide mouth at the top narrowing below, and is so adjustable by means of a hand wheel that the open mouth is kept above the level of the beer and below the level of the yeast. The latter naturally gravitates into the chute and falls into a tank below. The yeast is assisted towards the parachute by being pushed with boards as shown in the illustration on page [illegible].

Another method is by "pontos"; these are vessels having the appearance of a barrel placed on end and have a capacity of eight barrels each. In the head of each there is an aperture with raised boards on three sides, the yeast rising through the aperture and falling on the open side into a tank below. At Burton-on-Trent "unions" are extensively used; this system is somewhat similar to that of the pontos, but instead of a large opening, the yeast has to force itself up a bent pipe termed a swan-neck, before it leaves the beer.

After the beer is cleansed it is ready to be racked into casks for delivery. Racking the beer into casks is a department of a brewery where machinery is successfully used to enhance rapidity in the operation and an almost total absence of waste, the main feed pipes to the casks being fitted with a smaller overflow pipe through which any surplus is returned to a tank specially placed for the purpose.

The dominant note in every brewery is cleanliness. Every vessel, however frequently it may be used, is invariably cleansed after each operation, and all pipes through which either wort or beer is pumped or run is either fitted with a tap at each angle, or has some other facility for being readily inspected and cleaned.

J. H. BARNES.

[illegible]

[illegible] BACKGROUND [illegible] OTHER BREWERIES.

THE MATCH-MAKING INDUSTRY IN GREAT BRITAIN.

THERE is probably not any item of British manufacture that is so invincible a "globe-trotter" as matches. Go where one may in the footsteps of the white man, the way is strewn with "Home" made matches. Go over endless fields of ice in search of either Pole, and the long weariness of hope deferred is cheered by tobacco kindled by English matches.

Photo: Cassell & Co., Ltd.

FILLING FRAMES READY FOR DIPPING.

The match-making industry in this country is represented by about fifteen factories, employing in round figures about five thousand hands, of whom seventy-five per cent. are women. By far the most important firms are Messrs. Bryant and May and Messrs. R. Bell and Company, whose works in the East End of London were visited specially for the purpose of this article. These two firms alone employ a great army of workpeople, and on their premises can be seen all that is most up-to-date in the way of machinery, used under the most auspicious conditions possible. The experiment made by the Salvation Army to employ labour on the same lines has had to be discontinued.

Thanks to stringent regulations imposed by latter-day authorities, this industry is now equally salutary, and capable of being carried on under as tolerable circumstances as any other manipulated by workers of a similar class. The wages received range well above the average. That it makes but slight demands on physical strength and benefits by lightness of handling, accounts for the preponderance of women match-makers. To give an adequate idea of the interesting proceedings in such a diversified factory, one must necessarily take each department in turn. Saw-mills, wooden matches, wax matches box-making — wood, cardboard and tin — label printing, box filling and packing, for export, etc.

To begin with wooden matches. The particular wood used is pine, which, in as far as the London factories are concerned, comes exclusively from Canada, in spite of the various attempts intermittently made by shipments from other countries to win approval from British match-wood buyers.

The timber is delivered in planks of about ten feet in length by nine inches in width and three inches in thickness, which, after being sawn into suitable lengths, are placed on machines which cut them up into match splints at lightning speed. These "splints," or headless matches, are taken into a large room termed the "filling room," where, having been delivered in confused heaps, they are quickly reduced to orderly lines by experiencing a short sojourn on the "straightening" machine, thus being rendered convenient to be filled into frames containing about six thousand of these splints, every one separated from the other. The ends of these splints are then passed through a bath of heated paraffin, and then on to a "dipping" table, where the match composition is carefully spread at one thickness. Being pressed down into this, they receive their heads. This process

is conducted in an isolated room specially provided with a large central ventilating shaft, which carries the fumes right into the open air, and prevents the disastrous results to the workpeople hitherto somewhat prevalent in less properly conducted factories. They are then placed in drying rooms to dry. When thoroughly dry they go to the box hands, whose quick fingers deftly pick up scores at a time and place them in the boxes.

The workshops generally, and especially those where the highly inflammable paraffined wood chips are handled, do not depend for immunity from accidental fire on the ordinary precautions of hose, buckets, and tanks of water, but are supplied with overhead water pipes fitted with automatic sprinklers, so that on a fire occurring in any portion of the room, that portion would be instantly subjected to a shower of water automatically released by the heat.

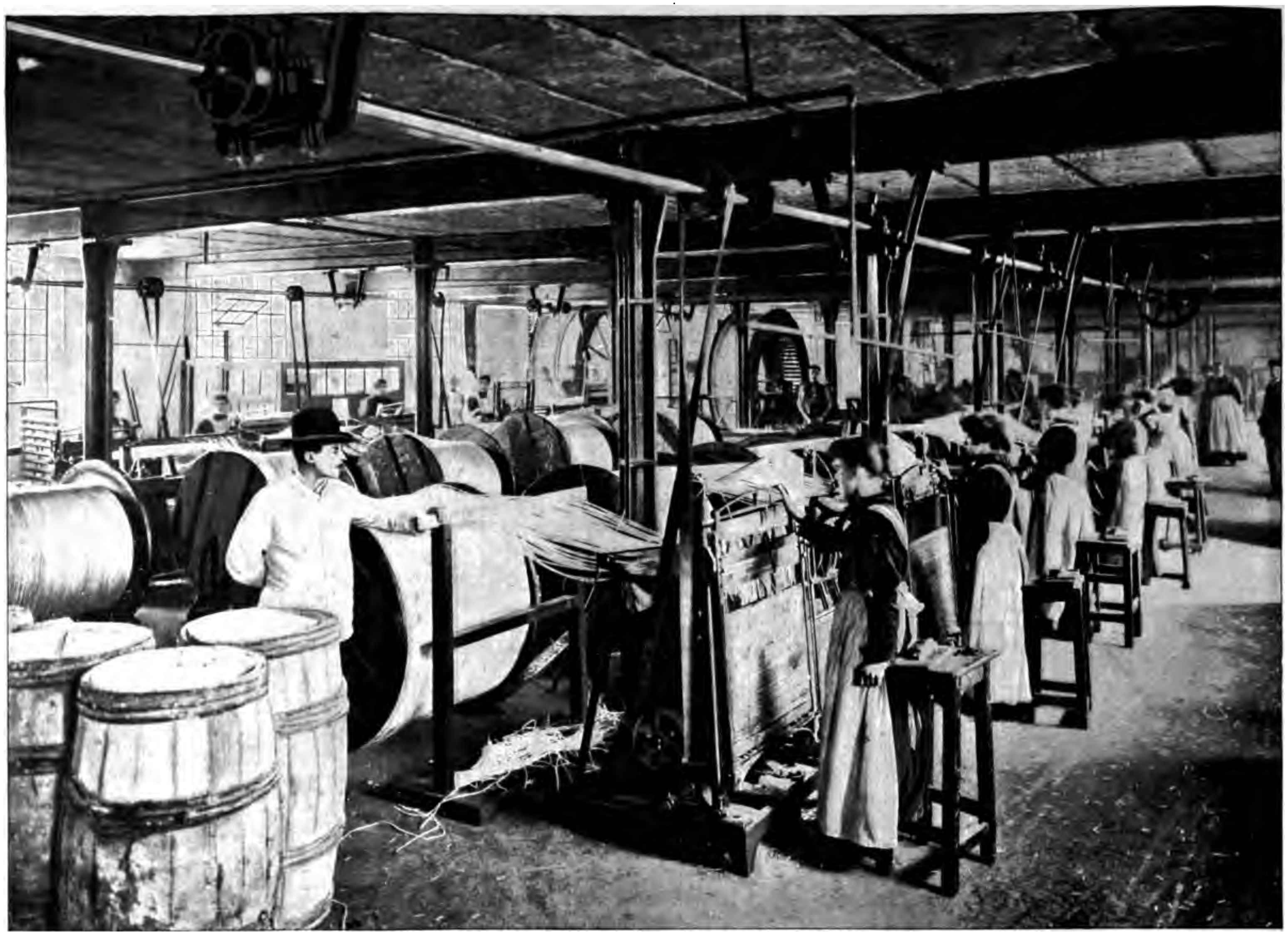
To "tapers," or wax matches, is conceded by far the most important division of this comprehensive factory, for through the immense colonial demand, and by nature of the comparatively extensive space which their [illegible] considerable attention.

The wax match comes into being in the following manner. [illegible] separate strands, each strand [illegible] yards [illegible] These large reels [illegible] feet apart [illegible] wound [illegible] times, etc. [illegible] [illegible] The [illegible] [illegible] boards; a knife descends and cuts them off. At each descent it severs the one hundred strands. The attendant girl drops a fresh board, and another one hundred are presented for decapitation; and so the process goes on until every board has been dropped and the frame-full is finished, which means that eight thousand wax matches are ready to receive their crown of usefulness. Gripped tightly by the "Venetian blind" suggestive frame, they are taken from the cutting machine, put into a lift, and shot up to the roof of the factory, there to get the finishing application of phosphorus. These are the conditions prevailing at one of the best regulated London factories, where we have been permitted to take photographs.

The rate of payment in match factories is arranged, except in the case of new hands, almost exclusively on the "piece-work" system—at all events, as regards the girls and women; heads of departments, overseers and so on receive, on the contrary, a fixed wage. Girls are employed in this industry as soon as they have succeeded in passing the standard pronounced by the School Board authorities to be the high-water mark of obligatory education. These learners, being totally raw material, are only worth [illegible] expense, so until they emerge, for better or worse, from their chrysalis of ignorance, they earn but a set five shillings or so a week. But the bright and energetic ones are soon able to get themselves transferred [illegible] the ten shillings rank, with the [illegible] shillings within reasonable [illegible]

The [illegible] "hands" are prompt [illegible] the first opportunity of being [illegible] "piece-work," since by this [illegible] arrangement only can their indi[illegible] any effect on their [illegible]

[illegible] strands and [illegible] under "the [illegible] paid by piece at [illegible] frames. Quick [illegible] frames a day. It [illegible] interesting calculation to find [illegible] how many yards of [illegible] match lengths each [illegible] in the ten hours which make her working day.



FILLING FRAMES WITH WAX STRANDS.

Photo: Cassell & Co., Ltd.

DIPPING MATCHES: PHOSPHORUS WORKERS ON THE ROOF.

The roof-workers are all men and boys, and the open-air treatment is the latest advancement in the way of modern sanitary conditions demanded by the authorities. The satisfactory result to the workers (of the change from covered-in rooms to four-winds-free passage of air standing place) is the total disappearance from amongst them of that distressing complaint known amongst match-makers as "phossy jaw." The mixing of the phosphorous paste and the heating of it ready for application to the "framed" match lengths takes place practically in the open air, well removed from the rows of little sheds full of shelves, whereon rest countless thousands of freshly topped matches getting dry.

The box-making, from the very size and variety of the article, naturally monopolises a large share of space in the factory under our notice. Each division of the industry—wood, cardboard and tin—goes at a truly astounding rate of speed; and each is undertaken by women and girls, the preparing of the wood and sheets of tin having been previously done by men.

The rapid reduction of whole tree trunks to wafer-thin slices of wood by means of a machine revolving against a plane is a sight that borders on the marvellous. Not only are these delicate shavings instantaneously produced, but they are cut into the correct length and breadth to make boxes, and, in the case of the *outsides*, are gently notched to indicate the spot where the folds must presently come. The timber employed is exclusively Aspen, from Sweden. Each wood match-box, of course, consists of three pieces—the entire outside being one, the base of the "drainer" the second, and the upstanding sides of it the third. The first process in wood box-making is to colour the edges of the outside piece; then bend it round, and fix it so by means of paste with an (previously printed) encircling label. The strip of sandpaper for striking on the side is then added, and the box-cover is completed. The inside needs but one operation—to attach the bottom to the bent strips of wood which form the four sides by the use of a long narrow piece of pasted paper. In most factories both parts of these boxes are made more frequently by hand. The triumph of ingenuity, however, is surely reached by a machine which not only folds and makes the outer case, but affixes the sand, and simultaneously prints the label! This complicated task is accomplished at the rate of 400 gross a day. Such a comprehensive machine is, however, not in very general use. Hand labour is more employed in turning out the cardboard boxes destined for wax matches, though these also are often done by machine; but in that case the sandpaper strike-piece is invariably affixed by hand, as is also the paper flap which covers the rows of

matches, and the little tab by which the box is pulled open. To make such boxes by hand from start to finish requires nine handlings. The comparative payment of the two methods is—boxes, *insides* only (for wax matches), made by machine, eleven gross, 2½d.; by hand, one gross, 2½d., and this quantity is attained by good workers per hour. A similar speed and scale of payment applies to the outsides, though not exactly identical, since there is so much more work entailed.

In every department, whether managed by machine or hand, the work is achieved with almost incredible speed, and the quantity produced by each employee looks to the inexperienced eye impossible of comprehension. As an instance, the women who stand at tables piled high with cardboard box-outsides, paste, stick on and drop into large baskets beside them, sixty gross of sandpaper strips every day! Their hands do verily seem to move at lightning speed; applying paste to a smooth board on the table edge, picking up neatly heaped dozens of paper strips, dabbing them down in rows in the spread paste, and then catching them up again one by one with the right hand, whilst the left takes up box after box from the mountain before them. A flashing movement of the deft hands and the paper is in place, the box dropped, and another in course of operation.

Photo: Cassell & Co., Ltd.

SIFTING WOODEN MATCHES.

There are, in the case of almost every factory, some scores of people employed outside the establishment, women who from one cause or another find it impossible to go out to earn their wages, and are, therefore, glad to be enrolled as home-workers. They do boxes only, the match-making not being practicable in little dwelling-houses. These home workers are supplied by the factories with the various parts—strips of wood, cardboard, paper, etc.—and they are at liberty to bring back the made boxes at a given hour daily. It is very usual for whole families—with the exception of the strong male members—to work at the boxes, mother, several children, and sometimes grand-parents, all contributing various divisions of the required labour—one will bend the wood strips, another will paste the paper wrappers, another will stick those round, a fourth will set the finished boxes aside to dry, and so on. The home workers are paid at the same rate as those who spend their time within the factory walls, and, unless they make special arrangements, they are not compelled to finish their work by any stipulated day.

The necessity to make tin boxes leads most match factory owners to enlarge this division of the undertaking by turning out many varieties of tin receptacles, such as ornamental tea caddies, little round boxes for blacking, and numerous smaller editions of the sort that chemists fill with ointment, etc.

The machine has the entire monopoly in the making of tin boxes, and a very lightly constituted manual machine it is, one turn of a half-circle, there and back again, sufficing to cut the sections of any shaped box out of the inserted sheet of tin.

The mottled effect sometimes seen on variously coloured tin goods which in the trade is known as "crystallising," is produced by a most ingenious process. Each sheet of tin is heated over gas jets, and when very hot is laid in

an iron-lined sink in which are dozens of little holes. On the hot tin being laid in the sink, a tap is touched, and up through the holes suddenly shoot vigorous jets of cold water. It is the sharp contact of these water needles with the heated tin that produces the pattern, to retain which the sheet is plunged into a bath of acid, after having been rubbed with whitening. The whole transformation of a plain sheet of tin to a closely patterned one occupies just two-and-a-half minutes. The various colours are produced by varnishing with different coloured varnishes and afterwards stoving.

In the matter of filling boxes with matches the girls employed become so deft, that to do 360 boxes in an hour, or twenty-five gross in a day, is not considered at all a record score. They seize long, evenly laid rows of matches and cram them into the ready-opened boxes with the most absolute disregard for the likelihood of fire. A match is dropped on the stone floor, a thick boot casually passes over it, a snap, a flare, but nobody thinks of taking any notice, for some other passer-by is almost sure to put it out—or eventually it will put itself out—so why bother, when the aim of one's busy hands and active brain is to fill more boxes in the given time (and therefore take more money) than all the other girls ranged along all the other benches in the workshop?

Sometimes, however, a halt is unavoidable; for by some unlucky chance a whole handful of matches in the act of being put into a tin box will ignite. That is the moment for self-possession. To drop them would spread instant disaster, but to hold them firmly is the pride of every good worker, and to plunge the whole flaming lot into the neighbouring bucket of water is her immediate intention.

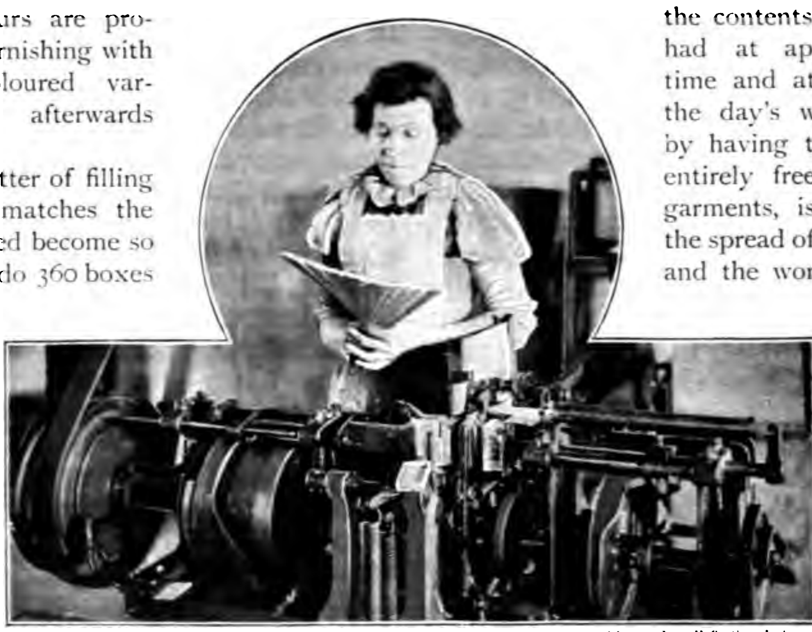


Photo: Cassell & Co., Ltd.

MAKING WOODEN BOXES FOR MATCHES.

The workers in this department are obliged to deposit their street clothes (hats, jackets, ties, etc.) and the food which they bring for their mid-day meal in a cloak-room which is kept locked, and the contents can only be had at appointed rest time and at the end of the day's work. Thus, by having the workshop entirely free of hanging garments, is the risk of the spread of fire lessened, and the workers are not allowed to get their food until they have been seen to wash both hands and face in lavatories where keen-eyed inspectors see that this beneficial regulation is thoroughly complied with.

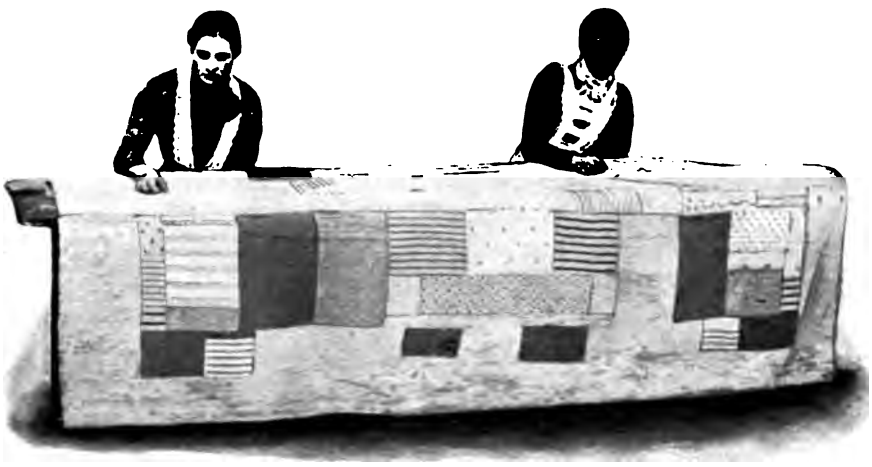
One is glad to note that the inevitable monotony of the match girls' hours of work is alleviated by the permission to talk to their neighbours. The constant flow of quick chatter that goes on, in spite of unsurpassably rapid work, shows that the privilege is appreciated. That it shall not be abused and noisy behaviour ensue, is the responsibility of the men and women, heads of departments, who ceaselessly perambulate each workshop, watching a moment here and there whether the "hands" are giving proper care to each item as it passes quickly through their clever fingers

It is also pleasant to record that in the particular factory under our notice there exist various schemes for the amusing or improving of hours of leisure; an interesting fact disclosed by an inquiry as to what use is put the stage which crosses one end of a long hall with tables and benches where the women and girls assemble during the daily dinner hour. The factory owns its own orchestra, composed of a score of men, conducted by an overseer, and musical entertainments are periodically given, to which some of the girls contribute vocal items of more or less merit. Occasionally a play is undertaken, when everybody possessing any dramatic talent is entrusted with a part.

Such a state of things betokens the existence of a very satisfactory feeling of sympathy between employers and employed, and one could wish that it were more prevalent.

I. Brooke Alder.

HOME WORKERS (MATCH-BOX MAKERS) TAKING AWAY WORK.



QUILTERS AT WORK. *Photo. Cassell & Co., Ltd.*

WELSH COTTAGE INDUSTRIES.

I.—QUILTING, KNITTING, AND NETTING.

THE picturesquely whitewashed and thatched cottages of "gallant little Wales" are the home—although, alas! not such a busy one as in the good old days—of several useful and beautiful domestic industries, of which, if we except spinning and weaving as fast outgrowing their humble origin, the old-time art of quilting may now be said to be the chief

Many a careful housewife sets the "cawl" (broth) before her Taffy, and celebrates her tea-drinking, in her kitchen amidst the baking "plank" bread and the pathetically recognisable portions of her slaughtered piggy, that the quilting frame may occupy the parlour. To be sure, a Welsh cooking place is a rarely artistic corner with its flagged floor, lattice window, ancient oak settle and dresser, the last a picture in itself, with "old Swansea" and the forgotten but now prized "lustre" china, and collectors would rejoice in an invitation.

In small cottages the importance of the quilting frame banishes even the great bed with Taffy and the tea parties to the kitchen, where its checked gingham canopy and ample proportions touch the rafters and barely squeeze between the wall and the ingle nook.

Sunday alone supersedes "the frame," when the quilting room becomes the "Bible parlour." The work is tucked away, the old three-legged table is dragged forth and ornamented with a crochet mat on which "the Book" is reverently laid, and the family burying cards hanging on the walls are the only connecting link between seventh-day smartness and workaday week-days.

The quilting frame is simply two lengths of wood, generally black with age, connected by two cross bars and raised on supports about four feet from the ground. It is capable of reduction or enlargement by means of holes and wooden pegs. A ribbon of coarse webbing, to which the quilt is tacked, is nailed to the inner side of each length and crossbar. The method of work is ingenious but excellent. The material to be quilted is carefully measured into quarters and eighths before it is tacked in the frame, so that the vegetable down stuffing may be evenly distributed. A pound to a pound and a half is used for each quilt, and this is quartered and halved again to correspond with the divisions on the fabric. When all is ready, the top piece of material is laid on and the work begins. The advantage of the vegetable down stuffing over the eiderdown stuffing is that it washes beautifully, and, owing to the close stitching of the Welsh workers, without fear of displacement. Lately eyelet holes have been introduced, so the quilts are now well ventilated as well as sanitary.

The patterns of the stitchings have an old-world charm all their own. The design invariably starts from a round and elaborately sewn centre, and spreads outwards in quaint branches of leaves, flowers and fruit. I asked an old dame where she learnt her patterns. "From my mother," said she. "And where did your mother learn them?" "From little Annie's great-grandmother, to be sure," she replied, puzzled by the simplicity of the question. And so it is; the little flowers and leaves originally cut out from nature in paper with the stamen and veins carefully chalked in have been handed down from generation to generation, suggesting that the Welsh are rather imitative than initiative in art; however, the result of these copyings is a very charming and original form of conventionality. The design is always clearly indicated by the laboriously neat runnings, no smallest detail being neglected.

Finer and prettier materials, such as washing silks and chintzes, are being introduced, and the Welsh quilts are now things of beauty as well as of everlasting wear. Especially attractive are the bassinette covers, which are a most successful departure. Formerly the quilts were of dark blue or red homespun cotton and much heavier. Folks required counterpanes that would wear then, as they were, and in fact still are, handed down with

Photo: Cassell & Co., Ltd.

HAND KNITTER.

Photo: Cassell & Co., Ltd.

MACHINE KNITTER AT WORK.

the oak and china to posterity. The present day quilts resemble dainty wadded bedspreads rather than eiderdowns.

There is a regular local demand for the cotton-covered counterpane, and many of the cottage workers, when enterprise in more attractive materials is suggested, say they have quite enough to do with orders from the neighbouring farmers, a good solid quilt being a necessary portion of a well-to-do girl's dowry, and an elaborately stitched one as usual a wedding gift in the little kingdom as are fish knives in England.

The Welsh quilters are too apt to be content with this local trade, and are afraid to try, or perhaps fail to see the possibility of a larger market for their labours—an unprofitable attitude these bustling times. A band of devoted Welsh ladies calling themselves "The Welsh Industries Association" are doing much, by bringing up the quilting industry to the needs of to-day, and by putting the workers in touch with the buyers, to remedy this. They are accomplishing, in fact, for their country what the Scotch and Irish ladies have done for the crofters and the linen workers of Ireland. Royalty led the way by ordering some of these charming counterpanes, and now there is a general trade growing up beside the old local one,

[illegible] their shoulders [illegible] from cottage to [illegible] "works" [illegible] seen. The change [illegible] felt, but the [illegible] taken [illegible] kindly to [illegible] that [illegible] to be found [illegible] initial expense [illegible] hire out machines to [illegible] a plan that seems to work [illegible] Most of the domestic knitting machines now in use are of American origin. They are the narrow hand machines and the wide hand machines. These two are exclusively used in the houses of the "operatives." Power rotary frames and power round frames driven by water power or steam are used in the factories; some of these machines require the attendance of only one female, and yet the sub-letting of domestic knitters [illegible] a peculiar [illegible] of the trade. [illegible]

the machine is constantly heard from cottage doors, but it is doubtful if the Welsh themselves do not prefer the hand-made stockings to be seen on the stalls at every market and fair; at any rate, there is still a good deal of hand knitting done by the rural people, and recently a fresh impetus has been given by the revival of hand-knitted golfing and shooting stockings. The finish of the hand-made hose is certainly softer and finer than that of machine-made goods.

But hosiery is not the only product of the busy cottage knitters; shawls, gloves, children's gaiters, cardigan jackets, and jerseys come fresh, and often beautiful, from the little frames, and the white, hand-manufactured goods made from the wool of the pure bred mountain sheep are especially worthy. The "Welsh wig," a sort of nightcap in black worsted, is still fabricated and worn under the "Jim Crow" hat; instead of the white frilled caps and the "high" hat of old, now almost as extinct as the dodo—the last one I saw was being buried by an old dame to save it from the ridicule of the younger generation! Wales generally, and especially Carmarthenshire, with its many strong, rapid streams, rivers, and waterfalls, is a country peculiarly adapted to the generating of electrical power; and thinkers who have the interest of the Welsh at heart foresee a rosy and not far distant future when every cottager will apply electricity to his knitting machine or power loom. This would do more, perhaps, than anything to increase the output of the country and check the movement to the large towns, and consequent depopulation of the rural districts. While the rustic folks are slow of action and content with local consumption, the energetic ones will seek in fresh fields a market for their push and enterprise; and since it seems to be for the benefit of the nation as well as for the individual that the worker should remain on the land, the value of keeping the home together by profitable employment cannot be overrated.

Netting is immediately related to knitting, but is distinguished by the knotting of the intersections of the cord. In Wales, as elsewhere, it is one of the most ancient arts, being practised by primitive tribes at all times. In the old days the Welsh netting industry chiefly consisted of the finer sorts, such as curtains, d'oyleys, and the now almost defunct antimacassar. When these articles flourished the trade was considerable, and the art being easily learned, and the implements simple and inexpensive, workers were plentiful. Then antimacassars went out of vogue, and the netters endured a long period of depression. Lately they have commenced the manufacture of the coarser and more useful forms of their art; for many and varied are the purposes to which netting can be applied. A young but flourishing cottage industry now exists, and seems likely to grow up quickly and do well in the making of fishing nets, nets for catching game, for defending the cherries and strawberries from the ravages of feathered transgressors of the law, for the temporary division of fields, and for hammocks.

Net making, in spite of the introduction of several netting machines since the nineteenth century, continues to be a handicraft, possibly because of the wonderful dexterity which a little practice in meshing develops. The old "twine" nets are being superseded by cotton nets, the latter being much more easily handled and stored.

MARY BARBER.

MAKING AGRICULTURAL NETS. *Photo: Cassell & Co., Ltd.*

NEEDLE AND PIN MAKING.

NEEDLES and pins, those indispensable little articles so closely linked together by long custom and universal requirement, differ as widely in the methods of their

RUBBING NEEDLES.

manufacture as in the materials of which they are made. Few people realise how complicated is the process by which needles are turned out, or how long it has taken to bring them to their present perfection of finish.

Thousands of years ago our barbarian ancestors were content to sew their primitive garments of skins together with pointed, skewer-like strips of bone and ivory. The Egyptians, Chinese, Indians, and others progressed far enough towards the evolution of the modern needle to make fine sewing implements of bronze, some of which, found in Egyptian tombs, must be quite four thousand years old.

From these needles of ivory and bronze to the delicate, highly finished ones that may be bought at the present day in packets of twelve, and sometimes twenty-five, for a penny, is a far cry indeed, and the steps by which the one has grown out of the other are many and varied, and steadily progressive. A complete history of the needle would probably fill volumes ; suffice it to say that it begins on British soil with the establishment of a needle manufactory at Long Crendon, in Buckinghamshire, in the year 1650, for although needles are said to have been made in London by an Indian in 1545, and again by a negro in Cheapside in the reign of Mary, their manufacture as an industry was not begun in this country until the above date. Before then English seamstresses were dependent on Spain and Germany for their tools, and a needle was naturally, in those days, a thing to treasure, as readers of the quaint and amusing old play which turns entirely on the loss of "Gammer Gurton's" solitary needle are well aware. Later, the needle industry travelled to Redditch, which has since remained its centre. The town and neighbourhood teem with factories, one of the best known being that of Messrs. Henry Milward and Sons, to whose courtesy

POINTING NEEDLES.

the writer is indebted for much interesting information, and at whose manufactory our pictures illustrating the processes of Needle Making were taken.

STAMPING.

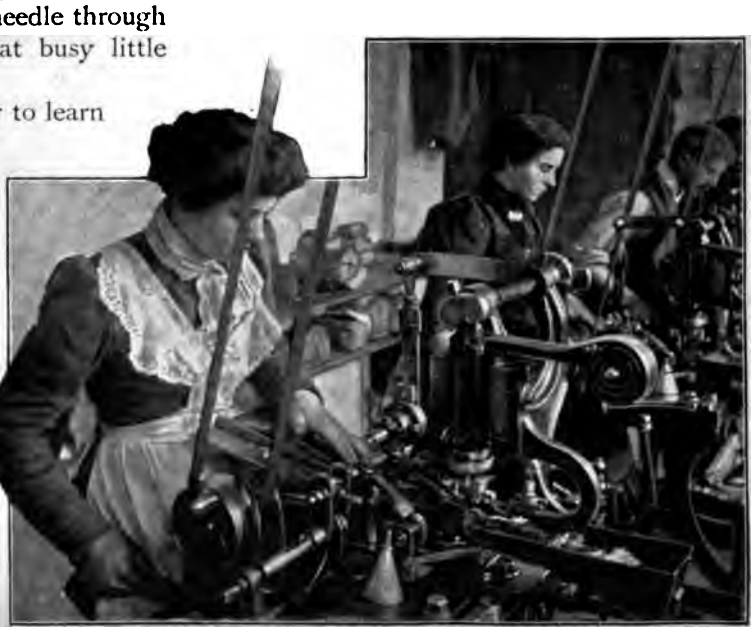
The weekly output of neeaies averages between seven and eight millions, a fact that makes one ponder on the amount of sewing done, or possibly the quantity of needles lost all over the world, for they are exported to America, China, India, and Africa, besides being sent to London, the Colonies, and the Continent.

To gain some idea of the quantity of work, ingenuity, and organisation represented by these facts one should, in imagination at least, pay a visit to the factory, and follow the wanderings of an embryo needle through the various departments of that busy little world.

It may surprise a good many to learn that no fewer than twenty-two separate processes are required to make the tiny steel instrument familiar to everyone, but the fact gives one an idea of the perfection to which its manufacture has been brought. A needle made in the year of Queen Victoria's accession is shown in the factory, and a comparison of it with one made to-day shows what strides the industry has made even in one reign, and what patience and inventiveness have been brought to bear upon it. A thick, badly shaped shaft, white in colour, with an irregular point, a head much larger than the body of the object, and a roughly-drilled circular eye: such was the needle with which the seamstresses of 1837 had to sew. The modern needle is fine, with an evenly tapered point, a head no wider than the shaft, an eye perfectly smooth inside and well shaped, and a polish like glass, so that it slips easily through the material sewn.

To understand to what a pitch of perfection needle making has been brought, one has only to examine the "calyx-eyed" needle, one of the latest developments of the article. As it is threaded through a slit in the top of the head instead of in the ordinary way, there must be sufficient elasticity to allow the thread to pass into the eye without being frayed or cut, and at the same time the sides of the head must be capable of springing together again so as to prevent the cotton from slipping out after the needle is threaded. It is evident that to ensure this elasticity the needle must be tempered with the greatest regularity; and extreme care has to be taken to make the sides of the slit perfectly smooth, so that the thread will not be cut whilst passing through it.

The needle makes its first appearance at the factory in the form of a piece of steel



PIERCING EYES OF NEEDLES.

wire cut into a length for two needles, and it has to undergo many vicissitudes before emerging as a finished article. It is thrown into furnaces, rasped by files, held relentlessly to grindstones, punched by heavy weights, rolled under great wooden rollers for days, and generally maltreated, but it comes triumphantly through its trials, to be snugly ensconced in a dainty packet and sent into the world, carefully labelled, the very best of its kind.

The first process the wire lengths undergo each one is kept revolving, so that the resulting point is uniform and even all round. "Pointing" was formerly done by hand, but the fine steel and stone dust was so dangerous to the operator that, in spite of the thick mufflers they wore over the mouth to prevent its inhalation, few of the "pointers" lived beyond the age of forty. In the pointing machine now used this dust is blown away through a pipe, by a steam fan, into a chamber specially constructed for the purpose.

SCOURING NEEDLES.

is the important one known as "rubbing." Fastened into bundles by means of rings passed round their ends, they are placed in a furnace, heated, and then taken out and laid on an iron-topped table, where a curved bar or "file" proceeds to rub them steadily, the bundles revolving all the time and thus bringing each wire in turn under the action of the file. This both straightens and anneals the wires, which are delivered from the file only to be placed at the mercy of the "pointing-stone."

By means of a rubber-covered wheel the needles are carried across the concave face of a stone driven at great speed by steam;

After the small preliminary operation of brightening that part of the wires where the eyes are to come, known as "skimming," to prevent any extraneous matter from being stamped in, they are carried off to the stamping machine, where the impressions for the eyes are made preparatory to piercing the latter.

Each wire is placed in turn on an anvil in which is set a die of the impression to be made, and a weight set with a similar die falls upon it, thus making an impression on both sides of the wire at the same time. Although stamping is now generally done by machine, it is still sometimes performed

NEEDLE-MAKING: MACHINE HANDING AND FINISHING.

PIN-MAKING: WIRE DRAWING.

by foot power, the workmen being so dexterous in this department that they can turn out between 27,000 and 28,000 wires per day, a number not far short of the machine output. Up to this stage of the needle's development the work has been done by men, but here woman steps in, appropriately enough, to make the eye, so essential a part of the implement.

Seated in rows behind the "eyeing" machines, tidy-looking white-aproned women feed the endless revolving screws which carry the wires under two punches exactly the same size and shape as the impression already made on them. When these have descended and pierced the required openings in each wire (it will be remembered that each length is made into two needles placed head to head), a small fork pushes the wire aside and gives the next one a friendly push into its place. For certain branches of work hand screw-presses are used, and, although the operation is much slower, the hand-eyer will eye 20,000 to 25,000 needles per day. This process, it is scarcely necessary to state, requires great care and skill.

The wires, which now bear a recognisable resemblance to their final shape, are next strung or "spitted" on wire passed through both eyes and handed to the "filer," who files off the burr made by stamping and, breaking the double wire into two lots of needles, files their rough square heads into neatly rounded form. The needles, as they may now be called, are then threaded on fine, slightly roughened wires, which hang from iron bars like miniature clothes-line props, along a table. The table is capable of being moved backwards and forwards by a crank, and the motion, shaking the needles violently, rubs the inside of the eye smooth against the rough wire. This "burnishing" is to prevent the fraying of the thread when the needles are in use.

Although now perfect in shape the needles are still useless, being soft enough to double up in the fingers. Into the furnace they go again, on iron pans, and after a certain time are taken out and slid into a vat of oil. Their sudden immersion hardens them, but they are now at the other extreme and very brittle, so they are tempered by a special patented apparatus which gives them the necessary elasticity.

PIN-MAKING MACHINE.

"Scouring," the next process, has a large mill devoted entirely to it, where the needles spend about nine days wrapped up, in company with soap and emery powder, in thick canvas, being rolled backwards and forwards under heavy "runners" of wood. When finally released from the scouring mill they are perfectly smooth, highly polished, and dark in colour.

Women next pick out by hand all broken or imperfect needles, arrange them in order with the heads all at one end of a row, and take away any that have in some way become shorter than their fellows. The speed and certainty with which this is done is truly amazing.

The grindstone again comes into play to "finish" the heads and sharpen up the points, and then the needles receive their final polish. The "wrapping-room," in which they are made up into packets ready for sale, is interesting chiefly on account of the machine at work there counting out with quite uncanny cleverness bunches of twenty-five assorted needles and delivering them on a tray to the "sticker" ready to put up. This work is also done by women, who are largely employed in the making of these especially feminine articles.

room itself. Here are rows of machines moved by steam power, which turn out pins at the rate of 180 to 220 per minute, the only hand labour in the whole process being the removing of the finished pins by the employees looking after the machines.

Watching the *modus operandi* of one of these unresting workers of steel and iron, one sees the end of a coil of brass wire on a revolving drum passing through a hole into the machine, being straightened and kept in its place meanwhile by iron pegs. It is

PIN-MAKING: WHITENING.

Almost more indispensable than needles are their companion necessaries, pins, but the mode of their manufacture is very much simpler, one machine doing nearly all the work that in the earlier days of pin-making required twelve or fourteen tedious processes by hand. The firm of Messrs. Kirby, Beard and Co., by whose kindness the writer has been enabled to gather in what fashion pins come into existence, is one of the oldest in the trade, dating back to the year 1743, and a sketch of their factory at Birmingham will give a good idea of the industry generally.

From the "wire-drawing shop," where the wire, placed in coils on revolving blocks, is drawn through holes in a steel plate to the various sizes required for making the different sized pins, one passes into the pin-making

seized by a pair of sliding pincers which put it through another hole, and as it comes out on the other side a little hammer strikes it, forming by successive blows the head of the pin. Then down comes a sharp shears, and cuts off the required length of wire.

Headed and cut, but pointless, the embryo pin falls into a slanting groove too narrow for its head to pass through, and thus a row of pins hanging by their heads appear along the front of the machine. These are carried backwards and forwards over a revolving cylindrical file with a graduated surface; their ends are held against the file, and in this way they are pointed, and drop into a receptacle beneath.

The next step is "silvering," for the pins, although they come from the machine perfect

in shape, are the colour of brass wire, and greasy to handle. After being thoroughly cleaned by revolving in barrels, they are spread out flat in steam-heated kettles, a fine tin powder is laid over them, a certain quantity of acid is added, and in this the pins are boiled for four hours. They come out bright and silvery, being thinly coated with tin, and are then dried in sawdust, put once more into revolving barrels to be polished, and freed from dust by being placed in a flat tray and tossed about in a fashion only to be mastered by long practice.

The next process is to look them over carefully, weeding out all imperfect ones, and then all that remains is to stick them in paper, which is done by a machine. The paper is mechanically crimped and placed in position to receive the pins, which are dexterously swept with a brush down an inclined plane leading to it by the girl feeding the machine. They pass into the latter in long vertical lines, a lever brings the paper under their points, a clever bit of machinery presses them into it, and row by row a sheet is filled with from 100 to 500 pins evenly arranged, and leaves the machine quite ready for the purchaser.

A special department of the factory employs girls to make the boxes and packets in which the pins are also put up. These vary from small ounce boxes to large decorated cases, and many of them are very pretty as well as useful, containing various kinds of pins in daintily designed receptacles.

JOSEPHINE BULLEN.

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STICKING PINS.

LONDON'S DOCKS.

It is an imposing spectacle to stand at a point of vantage—an upper floor of one of the many huge warehouses scattered about the docks—and gaze out across the vast acreage of water, with the busy, teeming cargoes, and large vessels are being laden with merchandise for exportation; craft having been "cleared" are moving majestically away for fresh supplies; others are moving in, loaded, bringing tea from China, ivory

THE WEST INDIA IMPORT DOCK.

life upon its bosom. The air is filled with the noise and clamour of unremitting industry; craft of all kinds are there, from colossal, leviathan liners to pigmy row-boats—Dignity and Impudence in close contiguity; mammoth cranes are swinging round with their costly and cumbersome loads, and floating derricks are also assisting to expedite the work of relieving the many argosies of their burdens; barges are receiving "overside" various from Africa, wool from Australia, tobacco from America in fact, merchandise from all parts of the world; steam whistles are shrieking, horns baying, confused shouting of voices, deafening clanking of metal, a feverish, pulsating activity. It is the daily routine, month after month, year in, year out, of the greatest port of the greatest city of the world.

There are eight groups of docks at the

Port of London. Six of these are under the control of one company, namely, the London and India Docks Company, formerly known as the London and India Docks Joint Committee. The docks are St. Katharine, London, West India, East India, Victoria and Albert, and Tilbury. The remaining two docks are the Surrey Commercial and Millwall, and they are managed by separate companies.

The St. Katharine Docks are situated near

UNLOADING CORN.

the Tower Bridge, and have an area of twenty-three acres, thirteen of land and ten of water. They are accessible only to small steamers employed in a coasting or Continental trade, although the warehouses receive some of the costliest articles coming into the Port of London. Large quantities of tea are stored here, it being estimated that no fewer than 867,000 packages, weighing 36,000 tons, are thus dealt with annually. When the packages of tea are received at the warehouses they are sorted, sampled, and marked by officers of the company and of the Customs. Eventually the tea is arranged into "shops," a shop consisting of three or more packages. The lids are then removed, and the contents exposed for the examination of the brokers. Ceylon tea is "bulked," that is, turned out on the floor and thoroughly mixed. It is no unusual thing for 200 tons to be thus reposing in a huge heap on the floor at one time.

Marble is received here from Italy, and such articles as wool, bark, gutta-percha, etc., are also stored. Adjoining is the East Smithfield depôt, used for both imports and exports. About 100,000 tons of goods pass annually through this place.

The London Docks, which are separated from those of St. Katharine by Nightingale Lane, are nearly a mile in length, and occupy a hundred acres, forty of which are water. They have vast vaults and warehouses, with a floor area of about 3,000,000 square feet, and a storing accommodation of 170,000 tons. In the vaults there is room for 105,000 pipes of wine. Miscellaneous goods are received, including wool wine, brandy, sugar, dried and green fruits, ivory, spices, bark, gums, metals, drugs, pepper, rice, coffee, cocoa, isinglass, etc. Ivory, when received at the docks, is weighed and carefully examined to see that no stone or metal has been inserted at the base of the tusks to increase weight; this deception is sometimes resorted to by natives. Some of the tusks are often nine feet in length, and weigh 180 lb. each.

Cinnamon, on receipt at the docks, is, after being examined by merchants, packed into bundles by a special machine. The accommodation for wool at the London and St. Katharine Docks occupies a floor area of 1,400,000 feet; and frequently as many as 1,400 labourers are employed in this department alone. It is estimated that 1,600,000 bales of wool, weighing 250,000 tons, and of the value of £20,000,000, is received

Photo: Cassell & Co., Ltd.

AT THE LONDON DOCKS: BUYERS SAMPLING WOOL.

annually. Each bale contains the shearings of sixty sheep.

There are over twenty-eight miles of gangways in the wine vaults, which, as already stated, have accommodation for 105,000 pipes of wine, being principally port, sherry, and Madeira. Visitors inspecting the vaults are supplied with a small oil lamp on the end of a stick, which serves to light their way and at the same time to denote to the vault-keeper how many visitors are present in the vaults. The temperature of the latter is 60° Fahrenheit, and varies very little summer or winter. There are also brandy vaults, and a bottling department. In the latter wines and spirits are drawn off from the cask, and bottled for exportation in bond.

We next come to the West India Docks, situated on the northern part of the Isle of Dogs. They occupy 244 acres, 105 being water, and consist of three parallel sets of docks, each about half a mile long. There is warehouse room for storing 150,000 tons of goods, and the principal articles received are rum, frozen meat, and various kinds of wood. A new entrance has now been added, 480 feet long, 60 feet wide, and 30 feet deep. In the import dock nearly the largest vessels coming into the Port of London can be received. The warehouse for the reception of frozen meat has accommodation for 100,000 carcases of sheep. The temperature is 13° below freezing point. The wood department covers an area of thirty acres, a large portion of which is under sheds. Cranes and electric travellers are used to remove the huge logs from place to place. Some of the logs of mahogany will realise as much as from £250 to £300 each. The largest ever received at the dock was 60 feet 6 inches long, 40 inches in breadth, 37 inches deep, and weighed 11 tons 18 cwt. On the north side of the dock is a large building containing the powerful machinery for pumping water into the dock to make up the losses caused by the ingress and egress of vessels. The water is, of course, always kept at one level in docks. A sight which nobody interested in the subject should fail to see is the docking or undocking of a vessel. The pumps at this dock are capable of raising 7,500,000 gallons of water an hour, equal to five and a half inches over the area of sixty-one acres which they feed.

In the rum department 40,000 puncheons of the value of £2,000,000 can be stored. The vaults of groined brickwork are 1,040 feet long

[illegible] square [illegible] and fixed [illegible] capable of [illegible] thirty tons. [illegible] steam are [illegible] lines [illegible] railway system [illegible] near [illegible] north [illegible] visitors. [illegible] The Albert [illegible]

[illegible] articles [illegible] tobacco, and [illegible] which are ac- [illegible] at the Victoria [illegible] Albert Dock is used [illegible] loading and [illegible] ships. The [illegible] the former [illegible] jetties instead [illegible] the case [illegible] docks of the [illegible] expedites the [illegible] goods into barges, [illegible] expense. The [illegible] warehouses have ac- commodation for 20,000 tons [illegible] at one time, the [illegible] which is [illegible] The frozen meat [illegible] accommodate [illegible] and additional accommodation is being pro- vided for a further 200,000 [illegible]

[illegible] the south side of the [illegible] are two dry docks, 500 and [illegible] respectively. Dry docks, [illegible] are for the accom- [illegible] requiring repairs. The [illegible] the water pumped out, [illegible] at the bottom. The [illegible] water is maintained in this [illegible] the West India, by [illegible] the pumps are capable of throwing 7,500,000 gallons an hour. Stretch- ing down the Thames, 1,120 feet, is a wharf, the water alongside being twenty-six feet deep at low water; here the largest vessels are able to lie, to coal, take in cargo, or embark passengers.

[illegible] Docks are [illegible] under the control [illegible] from Blackwall [illegible] a distance of three miles. The [illegible] berths [illegible] of the [illegible] accommodation for [illegible] smaller craft, and there is an area of [illegible] of water. The docks and ware-

The Tilbury Docks have a main dock and

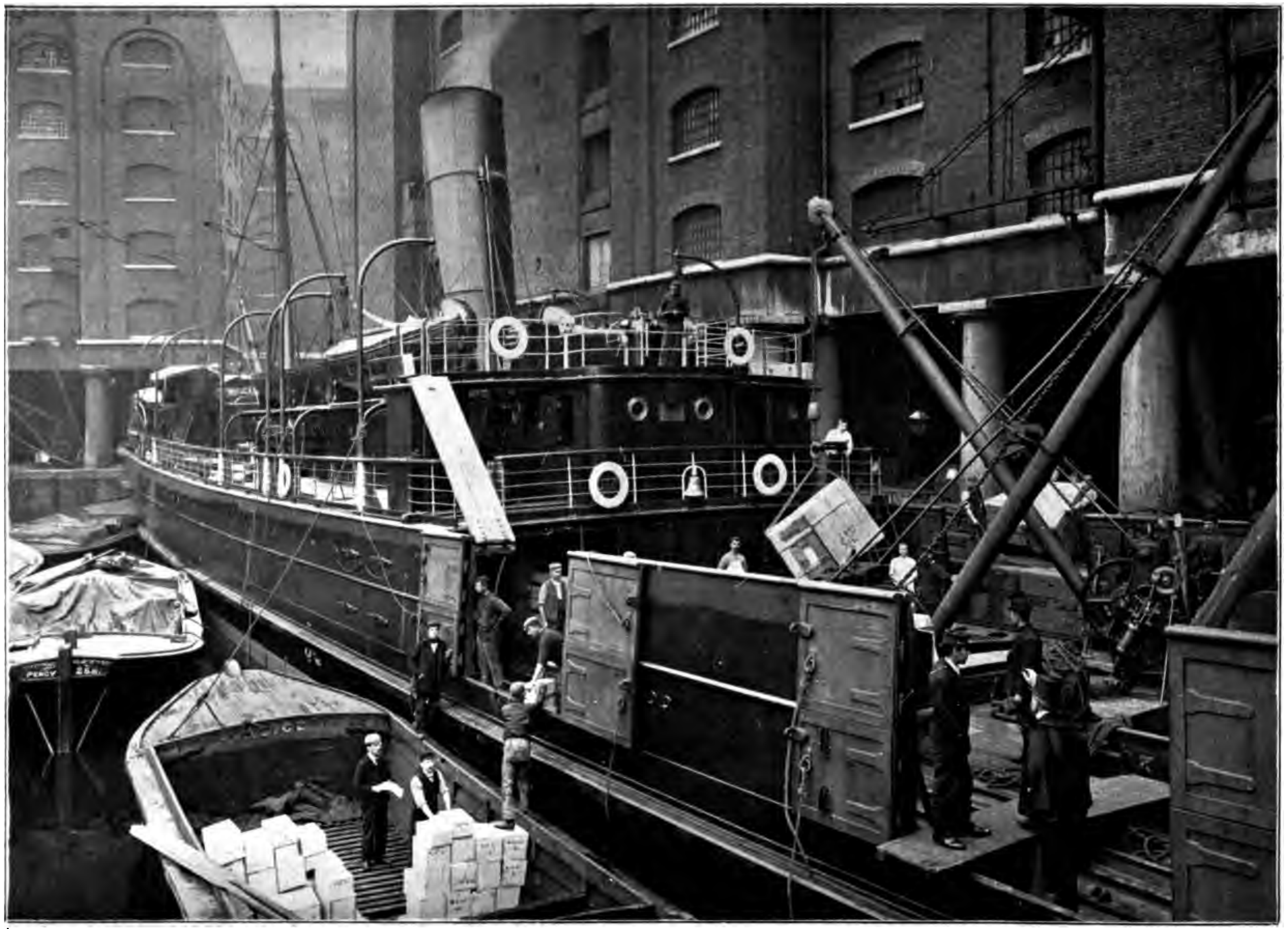


Photo: Cassell & Co., Ltd.

UNLOADING IN THE LONDON DOCKS.

three branch docks ; they are connected with a tidal basin by means of a lock, 700 feet long and 80 feet wide, in which are three pairs of gates. The main dock is 1,800 feet long by 600 feet wide ; each branch dock is 1,600 feet long, the centre one being 300 feet wide, and each of the others 250 feet wide. The total water area of the docks is fifty-four acres, and of the basin nineteen acres ; the depth of water in the main dock is thirty-eight feet, and in the basin at high water, spring tides, forty-five feet, and there is never less than twenty-six feet at the lowest tides.

Here are to be found the largest dry docks in the world, being 850 feet long ; they are enclosed and divided by six caissons, and can be emptied in one hour and a quarter by pumping out 12,000,000 gallons of water. There are twenty-four sheds, 300 feet by 120 feet, and three in the basin, and fifty-three hydraulic cranes, with a lifting power of thirty hundredweight each, capable of making a complete circuit in forty seconds. The engine-house for the hydraulic system is on a massive concrete foundation, and has a chimney shaft 120 feet high. It is fitted with three pairs of horizontal compound hydraulic engines, each pair of 175 horse-power. The hydraulic pressure is conveyed underground, through cast-iron pipes, and connects with travelling cranes, lock-gates, sluices, railway sidings, capstans, etc. The premises are lighted throughout by electric light ; there are twenty-six miles of rails, and direct communication with the railway system of the United Kingdom.

In addition to the docks, this company also has extensive warehouses at Cutler Street, Crutched Friars, Commercial Road, and West Smithfield for the reception of merchandise of a multifarious character.

The Surrey Commercial Docks are employed principally in the timber and grain industries. They are situated on the south side of the Thames, in the bend of the river which divides the London Docks from the West India Docks, and have a total land area of 217 acres, and a total water area of 166 acres. There are five miles of quays, seven miles of roads, and sixteen miles of alleys in yards and sheds, six timber ponds for floating timber, and 221 sheds for the storage of wood goods. These sheds will accommodate 61,500 standards — a standard being equal to 165 cubic feet. There are nine grain warehouses, with net holding capacity of 271,000

Photo: Cassell & Co. Ltd.

ST. KATHARINE'S DOCK.

IVORY STORE AT THE DOCKS.

quarters. The grain is taken from the vessels by self-filling and self-discharging buckets fitted to cranes on the quays, and delivered into hoppers, it being estimated that 120 lifts per hour can be made by each crane. The hoppers pass along on rails outside the buildings, and deliver grain into weighing machines, which are capable of weighing two tons at a time. From the weighing machines the grain is taken up by a system of band machinery, which delivers it on different floors of the granaries. During a recent year 1,466 vessels of various classes, carrying wood, grain, coals, and sundry merchandise, of the total net registered tonnage of 1,076,518, used these docks Seventy-five per cent. of the wood-laden vessels entering the Port of London come into the Surrey Commercial Docks.

The Millwall Docks are situated on the Isle of Dogs, to the south of the West India Docks, on the northern side of the Thames. They consist of an area of 233½ acres of land and 35½ acres of water; the entrance is three and a half miles below London Bridge, is eighty feet wide, with twenty-eight feet of water over the sills at Trinity high water; they have three pairs of gates, forming a lock 450 feet in length, which can be divided into two locks of 250 feet and 200 feet in length respectively. The principal portion of the dock is 350 feet wide, with a depth of water varying from twenty-eight feet in fairway to twenty-four feet by the quay walls. The total length of the quay is 3,040 yards, and near the south-east corner there is a dry dock 450 feet long by 65 feet wide, with twenty feet of water over the blocks at high tide. This is emptied partly by discharging the water through a culvert into the Thames, the remainder by pumping. Hydraulic power is the motive force used almost exclusively, and at the entrance lock there are thirty machines for opening and closing gates and working the sluices and capstans. The latter have a haulage power varying from one to five tons each. There are distributed about the docks sixty-five cranes, most of them of thirty-five hundredweight capacity, and moving about on rails of a seven feet six inch gauge. Some of these are on masonry foundations, others on timber dolphins situated about forty feet from the quay. The dolphins vary from 200 to 360 feet in length, and the advantage gained by their use is that goods can be lifted straight from a ship into a barge or *vice versâ*. The principal trade of the docks is grain, of which about 3,000,000

quarters are received and distributed per annum, which represents about one-third of the total grain imports of the Port of London.

Reference should be made to the system of pneumatic grain elevators employed by this company. They float on barges, and consist of a vacuum chamber, from which the air has been partially exhausted by means of steam engines situated beneath the deck of the barge. Flexible tubes pass from the chamber to the ship's hold, through which a strong current of air rushes to replace that driven from the vacuum chamber, and carrying the grain with it. The latter thence discharges into a garner, and feeds a number of weighing machines, which deliver to barges in sacks or bulk.

There are forty-eight miles of railway lines, which connect, viâ the Millwall Extension Railway, with the entire railway system of the United Kingdom. The company possess 1,500 railway waggons and ten locomotives, three of which are used for the working of their passenger traffic. Abou passengers are carried annually. recent year 1,337 vessels used th Docks, of a gross tonnage of 1,4 vessel is charged by a dock company to the tonnage of its cargo, not o itself—that is to say, according to occupied by the cargo.

Finally, taking the docks of collectively, we arrive at the followin able figures: There are 223,420 feet $637\frac{1}{2}$ acres of water, and 694 cr ricks, electric travellers, etc., in use.

Some idea of the vastness of Grea business with the world may be from the simple statement of fact th a recent year vessels of an aggregate of 15,400,000 entered to discharg Port of London. The nearest to Liverpool, with 9,500,000 tons; the the list was Hamburg, with 7,766, It is therefore clear that Great Brita an easy first in the race for co supremacy.

H. L.

A DOCK FERRY. *Photo, Cassell & Co., Ltd.*

WOMEN TOILERS IN THE BLACK COUNTRY.

AMONG THE NAIL, CHAIN, AND BRICK MAKERS.

Photo: Cassell & Co., Ltd.
GIRL AT THE BELLOWS—CHAINMAKING.

THE modern tendency of women with energy and capital to quit the fireside and engage in industry or trade is in significant contrast to the yearning of many women in the Black Country to be relieved from their toil. Life in the nail and chain forges and in the brick-yards is a perpetual struggle for existence. The conditions of work are not unhealthy, but the hours are so long that physical endurance is taxed to the utmost, and pay is so small that every member of nearly every family, capable of work, is obliged to add his or her mite to the slender income of the household.

The portion of the Black Country in which these three industries have become almost historic occupations lies within South Staffordshire and Worcestershire, and includes Stourbridge, Dudley, Cradley, Lye, Halesowen, and Bromsgrove. Mechanical contrivances have been introduced in our great cities for the manufacture of nails, notably at Leeds, where many dexterous machines are used, cutting, heading, and pointing the nails at one stroke; but on the hill slopes of Belper, in Derbyshire, and in the Black Country the methods are still chiefly manual.

In Bromsgrove—by no means a grimy-looking town, for it is rather quaint and clean than squalid and dirty—there are more women nailmakers than men workers. They are put into the industry because there is little other work in the district for them to do, and having passed their probation as beginners, by making rough nails that are scarcely marketable except in exchange for the cheapest boots and shoes, they are permitted to work on nails for the middleman or "fogger." Formerly, when the employer opened his warehouse, he gave out on certain days rods to be worked into nails. Now he seldom proffers the material. The nail-maker must buy his or her bundle of iron, valued at three or four shillings, before any work can be done; and inasmuch as there are women who cannot always raise such a capital, they have now and again to be idle and to realise the meaning of "clamming"—an expressive local term for starvation.

The men and women sufficiently well off to purchase the necessary rods work in the sheds or in their own cottages, and toiling often from six o'clock in the morning till nine o'clock at night, on an average sixty hours per week, can earn from eight to

Photo: Cassell & Co., Ltd.
BENDING THE ROD—CHAINMAKING.

ten or twelve shillings. One has heard in some trades of the peculiar counting that gives thirteen to the dozen, but this is a feeble trick in mathematics in comparison to the "fogger's" arithmetic in the Black Country, his notion of a thousand nails being *eleven hundred and fifty!* In buying he sometimes demands even twelve hundred for the price of a thousand; but invariably the nailmaker has to turn out eleven hundred and fifty nails for every thousand he or she is paid for, and though an advance of wages has been conceded the workers do not always benefit from it. The peculiarity of the nail trade, as followed in the Black Country, is that the master takes no risk. The worker has to find both the capital and the labour wherever he or she can, is obliged to submit to the loss consequent on the purchase of unsuitable material, and pays all sorts of charges to make industry possible.

Photo: Cassell & Co., Ltd.

NAILMAKERS AT WORK.

The nailer's cottage is both home and workshop. Generally, at any rate, the work shed is attached to the habitation and included in the rent. The shed is fitted with forge and bellows; but the nailer, usually the head of the family, has to procure his own bench and set of tools. On the bench is fixed an anvil, and a chisel, for pointing, bending, and partially cutting the heated iron, and a bore in which the severed length of rod is inserted. The "oliver," the heavy hammer, worked by a treadle, is close by, and fashions the head of the nail. The nailer does what he can to reduce the expense of production. He lets the bench room in his shed to other workers—or "stallers," as they are called—and these men or women pay sixpence per week towards the rent, and another ninepence towards the cost of the "breeze," or firing; so that a "staller" making twenty thousand Flemish tacks—really twenty-four thousand—a laborious week's work, would earn, paid at the rate of sixpence-halfpenny per "fogger's" thousand, ten shillings and tenpence: nine shillings and sevenpence, with his working expenses deducted. There are different prices for the making of hob, brush, clout, and many other sorts of nails; but the wage result differs little. The workers are poorly nourished because they cannot afford sufficient food, and they are ill clad because they have not the wherewithal to buy raiment. The world to them is a slavish den.

Bromsgrove appears to be inseparable from poverty, yet it is more comely than Cradley Heath. The centre of the chainmaking industry by night is bright with the glare of furnace; by day it is shrouded with smoke and gloom and flecked with mud. Here and there men or women are chainmaking in their own particular sheds, in comparative solitude; but most of the work is done in factories, and in some of these workshops there are five or six women at the anvils. Their tongues go in rough rhythm to the beat of the hammers and the clink of the chains they are forging; but there is no genuine mirth in their din. However womanly they may be at heart,

Photo: C. G. Mason, Stourbridge.

WOMEN MAKING RETORTS.

appearances are against them. In ragged or makeshift apparel, toil-stained, ill-fed, and haggard, they are the antithesis of the society beauties who ride in Hyde Park, or grace reception or ball at West-End mansion. The female chainmaker of the Black Country stands long at the forge. She has to work now and again with her child at her breast, or with a sharp eye upon the little one as it crawls about the spark-sprinkled floor. Whether her hands are blistered, or her body scorched with flying iron, she toils on, and, working twelve hours a day, earns from five to eight shillings per week! She needs no larder, for she lives from hand to mouth, and if her children can sit to a feast of bread, soaked in hot water and flavoured with weak tea, they become quite epicurean. The bellows blowers, both children and old men and women, are worse paid than the female chainmakers. They turn the wheels or pull the bellows beams at the rough rate of threepence per day, making, nevertheless, a substantial profit for the forge owners, who do not scruple to charge heavily for the "breeze" or fuel indispensable to the chainmakers.

Industry at Cradley and at Dudley is a Juggernaut. The woman has to toil till the birth of her babe sharply reminds her of the imperative claims of motherhood; the man has to labour under conditions that sap his strength, that utterly exhaust nature. In the Cradley district one thousand tons of chains is the average weekly output, and it includes nearly every variety of chains, from the heaviest cables to pit hauling gear, and to the familiar dog chains, swivels, and rings, for which the girl maker receives three-farthings or at the outside one penny each, and for which the dog fancier willingly pays eighteenpence. The woman, as a rule, forges the smaller and lighter chains, inasmuch as for this work less furnace heat is necessary. She heats the thin iron rod, bends the red-hot piece, cuts it on the chisel, twists the link, inserts it into the previous link, and welds it with the hand hammer or the "oliver," or both. The male chainmaker is engaged in the production of heavy cables, and is well paid for his work while he is at it, getting from seven shillings to ten shillings per day; yet he is so handicapped that his earnings have a better look in print than feel in his hand. He has to work in such intense heat that a portion of his wages is sweated out of him. He has the thirst of Tantalus, and assuages it with huge draughts of beer, the cost of which, however poor the quality of the beverage, ruthlessly diminishes the weekly sum available for household and other uses. The heat of the furnace saps the man's vitality, and two days' full work per week is as much as nature can withstand, especially as his constitution is soon undermined by the fierce alternations of heat and cold. Granted that he actually receives one pound per week for his toil, from this sum must be deducted the inevitable beer money, and two or three shillings for blast, the latter sum going to the employer as his share of the cost of fuel and blow—practically for the use of the furnace, worked by either steam or mechanical power.

Bricks are made in nearly every county in England, but it is in Staffordshire and Worcestershire that the works are the most

numerous and the output the greatest. Twenty years ago the lot of the brickmaker was even worse than it is to-day. Around the huts in the brickfield "sunburnt men, whose scanty clothes were of much the same colour as their skins, desperately ran their top-heavy barrow-loads hour after hour, under a perhaps almost tropical sun; there the barrow-loader ceaselessly swung himself from leg to leg as he lifted his tale of bricks on the barrow; while that other worker, who by her length of draggled skirt should be a woman, claimed no exception on account of her sex, but rough-shaped the rough clay and supplied the moulder next to her as if he were an insatiable machine and not a creature of flesh and blood." The wealthy son is said to be "born with a silver spoon in his mouth." There is a clumsy variant of the saying, the clay worker ruefully confessing that his boy is "born with a brick in his mouth." Anyhow, his offspring, boys or girls, are impelled or drift into his occupation. In many of the large brickfields machinery has ousted child labour, but brickmaking in the Black Country is still carried on to a great extent by hand—and feet. The moulder is paid by the thousand bricks. To see him handling the clay one might imagine that he was away in Egypt, hurrying at the command of Pharaoh's taskmaster. He is not only a worker but a taskmaster himself, inasmuch as he has to engineer his gang, usually members of his own family, to a profit. The clay is wheeled to the "pug mill," which, worked by steam or horse power, is self-delivering, and, if built to economise time, is within reach of the moulder; but if at a distance from his working place, the clay, cut in lumps to make three or four bricks, is passed on by the flat-walker to the moulder. He flings it into the mould, empties it, shaped, on the pallet board, and from thence it is carried away singly, or placed on the barrow-loader for transit to the hack to dry and to the kiln for burning. The introduction of brickmaking machinery has dispensed in some fields with both the flat-walker and the pug boy; but in the Black Country many women are still employed in the brickfields, not only in the manipulation of bricks, but in brick burning, dressing, and loading. The Legislature has restricted female employment to some extent, but the "clay dabber chicks"—the women workers in clay—have been allowed, like the pit-brow lassies at the Wigan collieries, to continue their toil. They are not so bedraggled as formerly. They work with naked feet, but their gowns are tucked up more or less neatly, and they wear a handkerchief head-covering, less glaring in tint, but tied something after the picturesque style of the girls who grind out barrel-organ tunes in city street. The men brick moulders make good wages, if they are persistent and temperate. The women are sooner fatigued, clay being a heavy and very unyielding material to handle; but, according to physique and conditions of employment, they earn from six shillings to twenty shillings per week, the latter sum, however, being considered quite a lucky wage, for though the female moulder, like the knight in the age of chivalry, is attended by a "page," who systematically carries away the product of her toil, she works in such intense heat and under such other disabilities that she seldom moulds more than eight hundred or one thousand bricks daily.

The report of the Select Committee of the House of Lords on the sweating system, commenting on the industrial condition of the nailmakers and the chainmakers of the Black Country, admitted that a hard week's work of twelve hours a day provided no more than a bare subsistence for the men and women engaged in the work, and particularly deprecated the treadling by women of the "oliver," the heavy sledge-hammer, as altogether too great a strain on the female organism. Wages are, perhaps, a trifle higher than when the report was issued, and there has been some little improvement in the industrial conditions of women's work in the Black Country: in fact, there is a more evident disposition to reduce, and even to abolish, female work in the brickyards. But the prevailing servitude is painfully reflected in the social life of the people. They are spoken of scoffingly as "peaky blinders," and are no freer than any other labouring section of the community from the rougher element; but in the main they are a hard-working, patient, enduring folk, especially when it is remembered that in their daily struggling the scriptural doctrine that riches are the root of all evil

Photo: C. G. Mason, Stourbridge.

WOMEN BRICKMAKERS AT WORK.

is reversed. To them the desperate need of money is the root of all evil, and in many homes Professor Huxley's saying sharply applies, for the parents, however thrifty and careful they try to be, are "bound by the fetters of want, and scourged by the whip of misery." The men, influenced by association, look upon the women, in numerous instances, merely as wage-earning partners. They prefer as sweethearts girls handy with the hammer in the forge or with the mould in the brickfield. And they consider it as an inevitable condition of wedded life that women should continue to bring pecuniary grist to the mill. Youthful marriages are common, and the inexorable fiat of life in the Black Country seems to be that the poorest couples should have the most children. At her wits' end, with many mouths to feed, the anxious mother does not always grieve at her baby's death. She has been heard to exclaim, "Thank God, it has gone back again!"

JOHN PENDLETON.

Photo: C. G. Mason, Stourbridge.

WOMEN BRICKMAKERS LOADING BARGES.

BEE FARMING— SHOWING THE HIVES.

BEE FARMING.

AN INTERESTING COTTAGE INDUSTRY.

OF all Britons at work there are few whose occupations are more interesting than that of a devoted and competent bee-keeper. Perhaps it would be better to call it a hobby rather than an occupation, though there are many who manage to make it not only a matter of amusement and interest, but of profit too. It is, however, hardly an occupation in the sense of being a business to which a person may devote his whole time and attention with a view to making a full income. There are in this kingdom no such "bee-farms" as there are in America. The vast expanses of flowering crops and the more equable climate of some regions of the Western world are more favourable to bee culture than the conditions prevailing in this country. There are American apiaries with their thousand, fifteen hundred, and two thousand hives, and honey producing is a considerable and very profitable business.

With us it is more of a cottage industry, carried on by those who have other occupations to rely upon, and who keep bees only as a subsidiary business at once interesting and profitable. In this fickle and uncertain climate of ours bee-keeping can hardly be

DIPPING BOARDS INTO MOLTEN WAX.

INDENTING THE WAX STRIPS.

recommended as a thing to rely upon, but any person favourably situated and well qualified to enter into it with intelligence and thoroughness may easily make a small bee-farm a source of income. There are thousands of cottagers who are able to pay their rent out of their beehives, and there are not a few who do a great deal more than that; but then they are people who not only are specially well situated as regards their rural surroundings, but they have exceptional qualifications for the work.

It is of no use for any person to attempt bee-culture who will not make it a subject of intelligent study and will not go to the trouble of thoroughly understanding bee-life in all its curious and interesting phases. Bee-keeping as our rural grandfathers understood it is all out of date; all the appliances of the business have been modernised out of recognition, as will readily be agreed by anyone visiting such an establishment as that of Messrs. Abbott Brothers, whose place at Southall we were recently permitted to inspect for the purpose of this article. Old fashioned methods of honey production are now quite abandoned by intelligent apiarists. The old straw "skeps" of the pictorial cottage garden are, it is true, still adhered to by some; but even they have changed their form, and the bee-keeper who should now stifle the population of his hives with sulphur fumes in order to appropriate their honey would be accounted a mere barbarian at the work.

Of course it may be well worth while to keep bees, quite apart from any question of direct profit from them. Not only are the little creatures an extremely interesting study, but it is now well understood that they play a very important part in the fertilisation of fruit trees, and a hive of bees near a garden will often enormously increase the crop of fruit. If, however, it is intended to set up a bee farm as a paying hobby or a serious business, the first thing it is necessary to consider is whether the locality is likely to afford them an abundant supply of that nectar from which honey is elaborated in the body of the bee. It is not merely a patch of flowers here and there that will keep a well-stocked apiary thriving. Bees will travel from their hives about two miles in any direction, and if they find anywhere within that radius large expanses of bloom in continuous succession all through the spring and summer, they will store enough not only for their own winter food, but if properly managed a large surplus for their keeper's profit. But in situations where there is no great amount of bloom within a mile or two it is of no use to start bee-keeping with any idea of making it pay.

USING THE "SMOKER."

Beginners are very apt to assume that bees are bees, and that one hive of them is just the same as another. That, however, is a mistake. There are races of bees almost as distinguishable to experts as the different races of men—different in appearance, in size, in working characteristics, in productiveness, in tempers and dispositions. Our native English black bee is in many ways distinct from others that have been imported from different parts of the world. In 1859 a distinguished apiarist introduced from Liguria, a compartment of Italy, a bee in size and form not unlike our own, but marked with yellow rings, and believed to possess many valuable characteristics. It has been found a better worker—getting to business earlier in the morning and sticking to it later in the evening, more enterprising in searching flowers that our bees neglect, more prolific, and, above all, more amiable in disposition, not so ready to sting, and therefore more conveniently and easily managed. In the same way we have had importations from Cyprus, from Palestine and other parts of Syria, and from some parts of Austria, each importation being supposed to have its special merits. With all of these there has, of course, been cross breeding, and practical apiarists find great differences in different stocks. This should be borne in mind in purchasing bees, and careful inquiry should be made into the lineage and character of their "queen." One of the first things that will excite the interest and astonishment of any beginner in the study of bees is the fact that the swarming thousands of them filling a hive to overflowing—twenty thirty, forty, and even fifty thousand of them —are all the offspring of one mother bee, the "queen" of the hive, who in the prime of her life will begin laying eggs early in the year, and will go on depositing two and three thousand eggs a day for weeks. That fact will, of course, suggest the importance of knowing a little about the queen from whom the entire colony will derive some of their characteristics. A queen bee will live for four or five years, and every year, if properly fed, will be more or less prolific, though she is most fecund when in her second year, and this is the age at which a commencing bee-farmer should start with her. The working bees, in the height of their labours at honey making, are worn out in about five or six weeks, and they die; so that unless the queen keeps up her egg-laying the hive will soon become depopulated. That, indeed, is her only business in life, and as soon as she begins to fail in that the workers get rid of her and set up another in her place.

EXAMINING A HIVE OF BEES.

One queen and her progeny will be quite enough for a novice to start with. A bee-farm such as is shown in our illustration should not be attempted by a beginner. It should be worked up to by degrees, and it is one of the peculiar advantages of this business that all the essentials of it may be learned just as well with a very small outlay and with only a single hive as by launching out on a big scale—better indeed.

To concentrate attention on a single stock is the best way to give practical value to the theoretical knowledge which, of course, the generality of beginners will have to gain in the first place from the careful study of some good treatise on the subject. When the aspiring bee-keeper has gained confidence in his handling of one hive, and has learned to understand the meaning of all that goes on in it, it will be quite time to add one or two more by swarming or by purchase.

Before getting any bees at all, however, it will be necessary to select a hive for their

TAKING A SWARM OF BEES.

reception. The developments of the past few years in these appliances are very interesting. Neither inside nor out are beehives at all what they used to be, and the depositing of honey has been manipulated and regulated until it has become quite a highly organised manufacture. The busy little dupes within the hive who, no doubt, still work under the delusion that they are prudently laying up store for the winter, are in fact all the time being inveigled into the filling of "frames" and little wooden "sections" holding just a pound of honey, all ready for handing across the counter.

And this is not the only way in which the indefatigable little workers are befooled in the hives of the modern bee-farm. The old system was to set up a straw "skep," and just let them creep in and go to work their own way, plastering wax over the straw walls, and building honeycomb all round the inside of their circular home. This laborious bedaubing of the rough interior and the building up of cells, of course, took a good deal of time, and in the bee world time is honey. Moreover, when the comb was built and filled it was difficult to get it out in any satisfactory form. But, besides all this, thoughtful observers soon saw that it was a very wasteful system from the bee-keeper's point of view. The wax for comb building is not gathered, like honey, from flowers, but is produced in the body of the bee and is exuded through the scales of the abdomen. It was computed that to produce a single pound of wax the little artisan consumes from ten to twenty pounds of honey. It was evident that if the wax-building department of the ancient business could be reduced it would mean a corresponding addition to the other department, the storage of honey, and ingenuity was directed to effect this.

The practical outcome of successive inventions has been to do away with the straw "skep," and to substitute a convenient wooden hive, and the earlier stages of the wax cell building are done by a machine shown in one of our illustrations. Thin sheets of wax are produced by dipping a board into the material in a molten condition and stripping the wax off when it is cold and hard. The sheets are then passed between rollers, which indent them on both sides with little hexagonal hollows just the size and shape of the cell foundations. These honeycombed sheets are fixed in frames and suspended side by side across the interior of the square wooden hive, filling the whole space, except that passages are left between the sheets just sufficient to permit of the bees crawling up over them. The industrious little simpletons creep into the hive and up among the suspended sheets, and, finding thousands upon thousands of cells apparently already commenced, set to work to finish them in the ordinary way. They are thus saved the trouble of producing a great amount of wax, and are able to get through the work of cell building and to begin depositing honey in only a small part of the time they would have taken over the business in the old skep. When the frames are filled, there is nothing to do but to uncover the top and just lift them out if they are required, or a supplementary

hive—a "super"—may be placed on the top, with crevices for the working bees to get through and continue their labours for the shopkeeper and the honey-loving British public.

The modern hive takes many forms that it would be impossible to describe here in detail, but we show some of them in our illustrations, and the principle on which they are all worked may be gathered from what has been said. The whole advance of the most efficient bee-keeping has been achieved by closely observing the inhabitants of the hive, setting up new houses "fitted with every modern convenience," and affording every possible assistance in their work.

One extremely useful idea has been hit upon for facilitating the handling and general management of the little creatures. It was noticed that, however viciously disposed at other times, bees very rarely stung when they were in a condition for swarming, and it was believed to be due to the fact that at such times they were replete with food as if in preparation for their change of home. It was also observed that they would similarly gorge themselves whenever they were frightened, and that a very simple way of startling them was to puff a little smoke upon them. A small apparatus, which we depict, was devised by means of which the smoke of smouldering brown paper or anything of the kind may be blown into the hive. The bees in their alarm rush to their honey, take their fill, and may then be examined or even freely handled with very little risk of their stinging. There are several forms of the "smoker," but they are all pretty much alike in principle. The same thing may be effected in other ways—by means of a fine spray of diluted carbolic acid, for instance.

The "honey extractor" shown in our illustration on this page is one of the latest of the inventions by which the work of the bee-farm has been so greatly facilitated. It is an adaptation of the principle embodied in the patent "wringing machine" familiar to anyone who has ever inspected a well-appointed modern laundry, where, instead of wringing the clothes in order to get out the water from them after washing, they are put into a wire cage and swiftly revolved. The honey extractor works in the same way. Instead of crushing the comb to squeeze the honey out, it is placed in a wire receptacle and made rapidly to revolve, the honey being whirled out by centrifugal force, and may be drawn off clear and bright and perfectly free from wax. The extractor is not absolutely essential on the bee-farm, but it is a very great convenience, and in some of its simpler forms it is quite cheap.

G. F. MILLIN.

THE HONEY EXTRACTOR.

THE PRODUCTION OF A NEWSPAPER.

THE morning newspaper as it comes to the breakfast table still damp from the press represents less an industry than a triumph of industrial organisation. In its production the telegraphist, the postman, the writer, the compositor, and the printer have all played their part, but behind these stands a great army of men whose skill and inventiveness have made it possible to utilise the work of the others. In no direction has engineering made greater advances, and in none have the results come so near perfection as in the building of the modern printing press. The paper maker achieves some of his greatest triumphs in the almost endless rolls from which a newspaper is printed. A modern newspaper office has become, at the behest of the engineer and the machinist, not so much a literary workshop as a great factory throbbing with intricate engines.

In 1846 fourteen daily newspapers were published in this country, and few had a circulation of more than hundreds daily. Now 250 papers are issued every day, and in the whole country there are 2,500 newspapers. Even with such vast expansion the production of a newspaper cannot rank with the greater industries. Probably 60,000 persons are directly engaged in newspaper offices, of whom 10,000 are writers. They are responsible for every kind of sheet, from the obscure weekly with its staff of two, who are at various times compositor, reporter, and editor, to the great London or provincial daily, in the preparation of which hundreds of men find employment.

Indirectly, newspapers probably enable as many more persons to earn a livelihood. The vast army of news-boys, of news-agents, and of bookstall-keepers has grown up as journalism has developed. The manufacture of printing machinery, of type, of typesetting machines, and of paper engage many thousands of persons. But to trace the industry through all these ramifications would be merely to illustrate the infinite complexity of modern conditions.

The office of a modern daily newspaper is divided into many separate departments, each complete in itself, and yet each in close touch with and dependent upon the others. Editors, sub-editors, reporters, and the army

Photo: Cassell & Co., Ltd.

IN THE SUB-EDITORS' ROOM, "DAILY NEWS" OFFICE.

of expert writers of all kinds are responsible for the "matter" which the paper contains, but after the written sheet leaves their hands it must be set in type in the composing room, must be made up into pages, these must be cast into plates in the stereotyping department, and finally the printing must be done in the machine room, in the half-darkness of which are huge machines each bearing its great rolls of paper, and fitted with all the devices for inking, cutting, folding, counting and delivering which make the modern printing press at once one of the most wonderful and intricate pieces of mechanism that we have. In evening newspaper offices, where every minute is of moment, and where ten seconds may mean the loss of a train or the earlier appearance of a rival sheet with an important item of news, all these departments are arranged so that every process goes forward in the most orderly and rapid sequence.

The first department of a newspaper to be busy is that in which the copy is prepared. News comes pouring in from every part of the globe. Many offices are completely equipped with private telegraph wires, worked by their own operators. In London, and one or two of the great towns, tape machines and column printing telegraphs are installed in the principal offices. A whole room will be devoted to these, and all day long they continue ticking out information gathered from every part of the world by the various news agencies. For the sporting services, wires are laid from the racecourses to the General Post Office, and from there to the newspaper offices, so that frequently within twenty seconds of the winning horse passing

Photo: Cassell & Co., Ltd.

THE LINOTYPE ROOM, "DAILY TELEGRAPH" OFFICE.

the post the result will be in the hands of the type-setter. From the tape machines, by post, by rail, and by every available means of communication the happenings of the world are gathered into the sub-editors' room, where an experienced staff quickly prepares the vast, confused mass of intelligence for the hands of the compositor, whose task it is to set up the news in type.

Within the last few years a far-reaching revolution has taken place in type-setting. Some of the great newspapers still cling to the old method in which everything is done by hand, the compositor picking up the types, each a separate letter, from cases before him, and arranging them in a small metal frame he holds in his hand. But the machine has displaced the man in most offices, although the finest work is still done

by hand. The modern composing room, instead of presenting a picture of rows of men standing before great trays and desks of type, is filled with gleaming machinery, working with a skill and certainty that appears more than mechanical. Although in some offices, and notably in that of the *Times*, separate types are set by machinery, in the vast majority of cases the Linotype machine is in use.

The compositor now sits before a keyboard, almost like that of a typewriter, and as he touches the keys, one by one there drop from separate compartments little pieces of metal, called the matrices, each with the form of a letter of the alphabet on its face. When sufficient of these to make a line have fallen into place, a lever is depressed, the line of matrices is raised and carried along, and after automatic spacing the hot type-metal is forced into the matrices, and in a second, as it were, a solid line of type is formed. Then the machine, as it goes forward with its work, picks up the used matrices, and one by one distributes them to the separate channels of the magazine from which they originally came. Machine setting is several times as speedy as the most expert hand work. A good compositor can set by hand about two thousand ens an hour, and each piece of type has afterwards to be replaced in its proper box. The machine under the fingers of a good operator will set 8,000 ens an hour, distributing the matrices, the lines of type being melted again when they have been used.

The "copy" as it comes from the editorial rooms is distributed sheet by sheet or paragraph by paragraph to the compositors, so that frequently a dozen or more men will be engaged upon the same article. When all have completed their "takes," as they are called, each block of type has to be arranged in proper sequence, and either then or before the sections are assembled an inked roller is passed over the face of the type, and an impression is taken on a sheet of paper. This is the "proof," upon which all errors and corrections are marked by a reader, to be quickly put right by the compositor. Then upon heavy steel tables, and within a flat steel frame rather larger than the page of a newspaper, the columns of type are placed in position until a complete page is made up, each item of news in the place that it will occupy on the printed sheet.

Photo: Cassell & Co., Ltd.

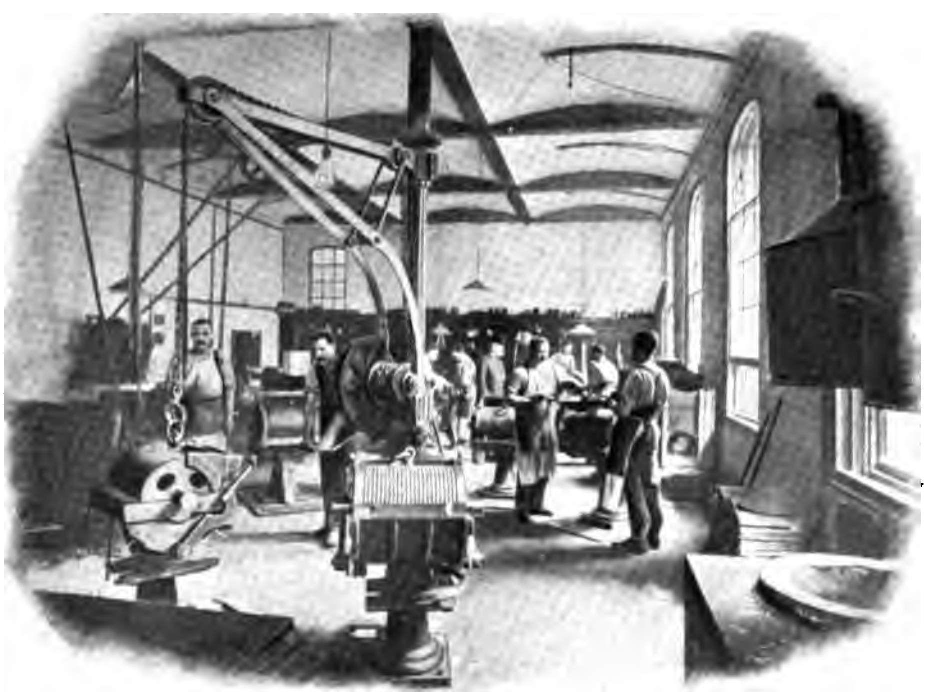
TYPE-SETTING BY HAND, "MORNING POST" OFFICE.

Simple as this operation seems in the description, in reality it becomes a very highly skilled class of labour, upon which only the most experienced men are engaged. The whole appearance of the newspaper depends upon the arrangement of the different items, all of which to the novice seem alike, and the man who can "make up" so that every item of news is given its due importance is almost an artist in type. When the arranging of the page is satisfactory, steel blocks are placed within the frame, a turn is given with a key and the whole mass of type is immovably locked together. The work of the compositors is done, and the table with the page upon it is wheeled or taken by lift to the stereotyping foundry.

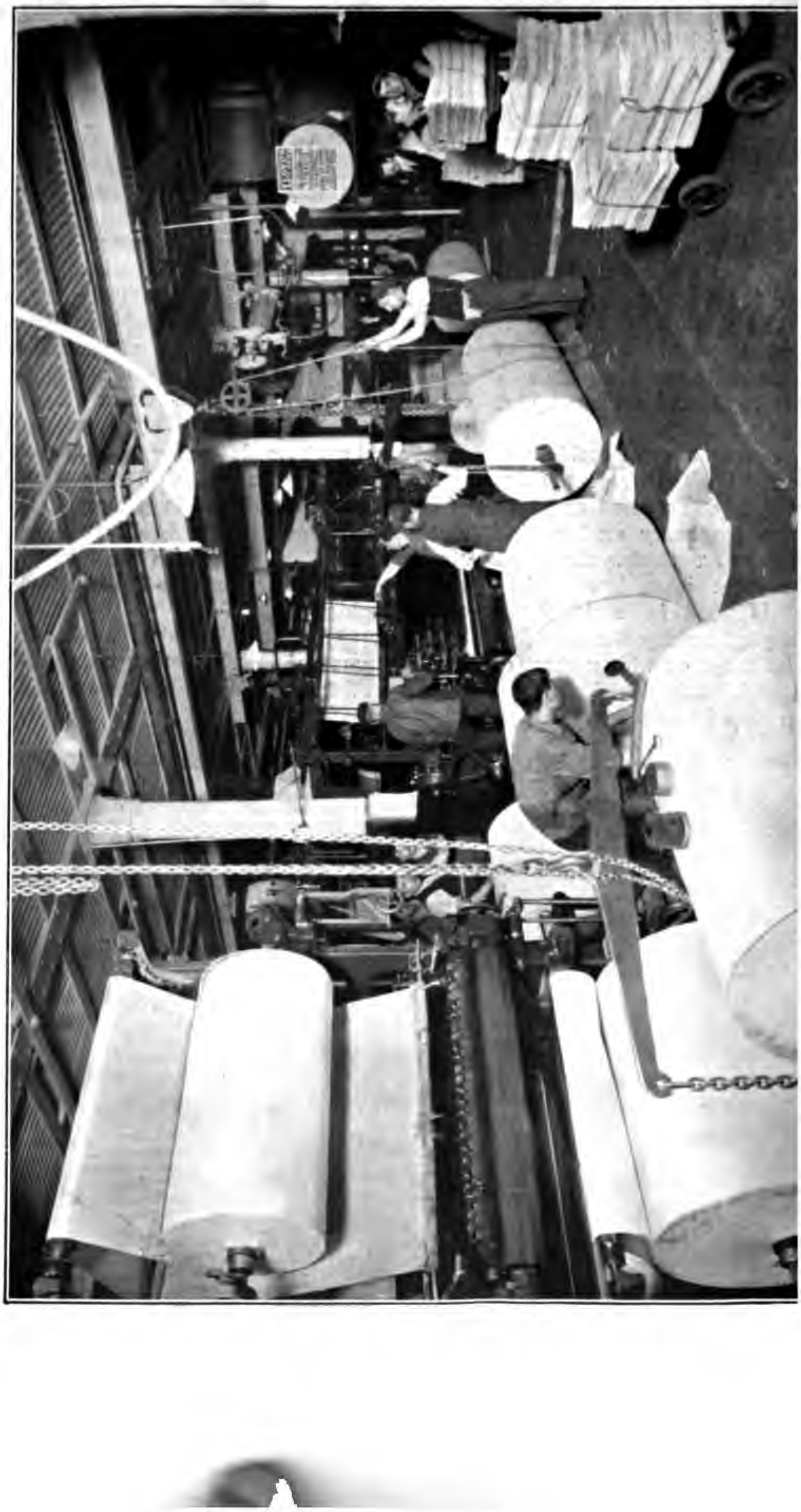
Here in one corner a great cauldron of melted white metal bubbles above the fire that keeps it hot, while scattered about, in precise order, are the heavy steel casting boxes, the machines for planing the metal plates, and the great press, like an iron mangle, which is used in making the matrices. With great rapidity the moulders cover the face of the type with a sheet of damp papier-maché, beating it down until the soft pulp is forced into every nook and crevice. The process is finished by running the page through the heavy rolling machine. The sheet of paper is quickly dried, either in a hot sand bath or a steam-heated press, and emerges of almost horny consistency with every dot and mark of the type deeply impressed upon its surface. This is the matrix from which the stereotype plates are cast.

In the time of the hand press, when editions were small and printed with great labour, the impression was obtained direct from the surface of the type, which rested upon a flat bed. When the rotary press with its rapidly revolving cylinders came into existence, printing from type was no longer possible. Obviously a mass of loose pieces of metal could not be made to cling satisfactorily to the surface of a steel roller. The solution of the difficulty was found in stereotyping; that is, in casting, from such a matrix as has been described, a mass of solid metal with the same circumference as the cylinders of the machinery.

The way in which this is done is simple. The papier-maché matrix, having been prepared, is fixed within a steel box, the interior of which is curved to half a circle.



"THE TIMES" STEREOTYPING ROOM. *Photo: Cassell & Co., Ltd.*



Hot metal is run in, and as soon as this has cooled there is a half-cylinder of white metal less than an inch in thickness bearing the impression of the original page of type upon its surface and of the exact diameter to fit the cylinders of the printing machines. Obviously a large number of matrices can be prepared from one type surface, and from these any number of plates can be cast, so that the printing of enormous numbers of a newspaper from many machines at the same time involves no more than one setting of the type.

As quickly as the stereotype plates are cast, planed, and cut so that they will exactly fit upon the presses, they are sent down to the machine-room and clamped into position, each page being properly placed so that the printed sheet as it issues from the machine will have its different pages in proper order. When all are in position the end of a vast roll of paper is carefully threaded through the different cylinders, the machine is started, one sees a flash of white and almost simultaneously numbers of copies of the papers, all properly cut, folded, and counted into quires, are thrown out of the press in a stream that never ceases until the roll of paper is exhausted.

A printing machine running at high speed is surrounded by the oil stained machinists, touching a screw here, oiling a bearing there, keeping careful watch over the paper as it runs through, for the least error of adjustment may mean the destruction of hundreds of copies, and perhaps the loss of a train. The machines, throbbing and pulsating, throw out the papers ceaselessly on tables, and as they come they are seized by willing hands, carried away, packed into bundles, and by hand, by cart, or by railway-train they are being carried over the country within a few minutes of the bare paper passing between the first pair of rollers.

Even then the work of the office does not cease. Most newspapers publish several editions—in the case of evening papers as many as fifteen sometimes. The pages of type are returned on their tables to the composing room. There they are unlocked, and unimportant items are removed to make room for later news that has arrived. In this way columns and even pages are sometimes sacrificed, and the whole process of re-casting the plates is gone through again for a second publication.

Photo: Cassell & Co., Ltd.

THE PUBLISHING OFFICE OF THE "DAILY EXPRESS."

All evening newspapers now use what is known as a "fudge" on the machines. This is an open space in one of the stereotype plates into which can be dropped a box bearing a late item of news in single types or in lines. While the machines are actually running there comes news of a great event, the verdict of a jury in an important trial, the latest score of the Australians, or it may be the death of a high personage. In a few seconds these announcements are in type, the running of the machine is stopped, the "box" is dropped into its place, and the machinery revolves once more, impressing some additional information in a position where before was but blank space. Many newspapers in this way publish the result of every important race at meetings all over the country.

As one of these great machines is running, the paper passing between the cylinders

at a rate of many miles an hour, white one moment and the next a complete paper printed on both sides, folded, and accurately cut, it is almost impossible to believe that only some thirty years ago even the *Times* was produced at a rate of little more than a thousand sheets from each press in an hour, and that every paper had to be folded by hand.

To-day the machine rooms of the finest newspapers are equipped with presses working from two and four reels of paper at the same time, and delivering newspapers cut, folded and counted at the rate of from 24,000 to 48,000 eight-page sheets an hour. Each roll of paper is five miles in length and of different widths, from about thirty inches to as much as eight or nine feet. In the largest of all the machines paper feeds into the cylinders at a rate that can be made to exceed thirty miles an hour. Even with this vast capacity for production the offices of our great newspapers are furnished with many of these machines, editions which are counted by the hundred thousand, and even by the million, being produced in the course of little more than an hour.

The production of a newspap through from beginning to end at pressure. In a few hours the be gathered, selected, cut down panded. Leading articles have to frequently being sent sheet by sl printers. A statesman makes an speech in Parliament or in so quarter of the country; a gre produced at the theatre, the curt at midnight; news comes of the a Sovereign—all these things mus with at once, frequently while th wait to close the last page. Eve is utilised by which a minute saved in any department, and no is too great that will enable one r to beat its rivals. Special trains every day to carry the papers t districts. In fact the production of paper brings into play, as perhaps else does, all those means of qu communication which have so redu size of our globe, and have brou nations of the world into closer as with one another.

ALFRED H. WA

LOADING A NEWSPAPER TRAIN.

THE MUSTARD HARVEST.

Photo: Ball & Co., Peterborough.

THE MANUFACTURE OF MUSTARD AND STARCH.

THE use of mustard as a condiment, and probably as a salad too, was known to the ancient world, and it was a favourite spice at the dinner tables of the Middle Ages. By the fourteenth century it had become so important an article of manufacture in Burgundy that Philip the Bold granted to the city of Dijon armorial bearings, in whose motto a punning reference to mustard may be traced. The Englishman of the Elizabethan age could no more eat his roast beef without mustard than the Englishman of to-day. Thus it was that, in *The Taming of the Shrew*, when Grumio asked the question:

"What say you to a piece of beef, and mustard?"

The immortal wayward Katharina replied:

"A dish that I do love to feed upon."

In those days, it would seem, mustard was prepared by the simple process of crushing the seed, as peppercorns are still. But in 1720 a Mrs. Clements, of Durham, devised a method of pounding the seed and then separating the flour from the husk, and the result was so agreeable to the palate of George the First that the new condiment, promptly called the Royal Flower of Mustard Seed, was largely advertised in the newspapers of the day, and from that hour to this mustard has been one of the serious industries of Britain.

The mustard plant is a member of the genus *Brassica*, to which we owe our cabbages and broccoli, our turnips and Brussels sprouts. Its two forms, black and white, grow best upon the rich loams of Yorkshire and Lincolnshire, Cambridge and Essex; and although it

MUSTARD OIL PRESS.

is also cultivated in Alsace, Holland, Italy, and other European lands, the British manufacturer does not find it necessary to supplement his own crops to any serious extent, so that mustard may be classed as a national product in a more complete sense than any other table condiment. The seed is sown annually, the crop is harvested with a sickle, as if it were a vetch, and the tiny pods are threshed upon the farm with a flail. The seeds, of which fifty weigh a grain, are conveyed in sacks to the factory, where they are stored in readiness for the long process of manufacture.

The seed of black mustard is smaller than the other, but it contains a larger proportion of the volatile oil to which the aroma of mustard is due. On the other hand, the white seed contains a larger share of the ferment which develops the pungent qualities of the seed, and it is therefore usual to mix the produce of the two kinds in order to obtain mustard in its highest form. After being thoroughly cleaned, the seed is dried in a hot kiln, a process which occupies much time, and it is then ready for the crushing mills. It is first shot into a machine wherein it encounters the implacable energies of a pair of smooth steel rollers, and passes thence to a system of wooden mallets shod with steel and working upon an eccentric crank, with the result that it is pounded past recognition. From this machine the pulverised seed—which is held together by the presence of oil, forming a third of its weight—is transferred to the sifting room. The sieves, of considerable diameter, are formed of silk cloth so closely woven that the number of meshes to the square inch reaches the enormous total of 30,276. The sifters are men of experience and judgment, for it is their task to watch the vibrating mass and to stop the machine at the precise instant when the whole of the flour has sunk into the bin and the coarser particles of the epidermis left behind.

The bin now contains nothing but pure flour of mustard, and in this form the pungent principle attains its most concentrated shape. It could be used as a condiment without any further treatment, but in this state it is found to be unsuited to the ordinary palate. Moreover, if left to itself ferment would develop, and a brown crust be formed upon the surface. It is therefore customary to mix with the pure flour a certain proportion of wheaten flour, the effect of which is to act as a sort of buffer and prevent the ferment from coming into contact with adjacent particles. This is not an adulterant, even in the sense in which chicory might be called an adulterant of coffee; but is a necessary ingredient of the mixture. It is, however, usual to sell it as an admixture, to comply with the Acts of 1875–1900, although law and custom nowadays recognise that the article called mustard is not a simple vegetable extract, but a commercial preparation in which farinaceous materials form an essential part. The admixture of the various ingredients is carried out according to the experience of each individual manufacturer, and the proportions are valuable trade secrets.

Photo: Cassell & Co., Ltd.

SIFTING MUSTARD.

It is in the packing department that the element of human labour is brought more conspicuously into play, and the task of making and filling the

packages gives employment to thousands of men and boys, whether it be the "penny tin" or the large 400-gallon tanks. These are destined to be used as a water reservoir upon an Australian sheep run or a South African farm, after being used for the conveyance to the colonies of the huge supplies of mustard which are exported to Britons over sea. It is in this department that the division of labour reaches its highest development. In one battery of machines the tin plates are cut into strips, in another these strips are slid beneath punches which fabricate the lids and bottoms of the tins, taking care in the process to impress the name of the manufacturer indelibly upon the metal. One machine turns the edges of the sides, another interlocks them, a third bends them into oblongs, rounds, or ovals, another fastens the bottom by a mighty squeeze, and an army of boys now take them in hand and fit the lids. Elsewhere a boy weighs out the condiment, and empties the scale into a tin held ready for him by a mate, who rams the contents with a rammer, and passes it on to another whose duty it is to place the lid upon it once more. The tin now reaches the pasting table, where a boy spends his days in pasting paper labels, which are placed roughly by another round the sides of the tin, and the finishing of this process by an older boy completes the tin as it is served to the thrifty customer in the grocer's shop. The packing and manufacture of decorated tins and of the tubs in which "loose" mustard is supplied, follow a similar course.

Photo: Cassell & Co., Ltd.

BOYS MAKING MUSTARD TINS.

At first sight it is difficult to understand why mustard manufacturers should occasionally combine with that industry the duty of providing their customers with starch as well. Few of the mechanical appliances required for the one are of use in the other branch, but the customers are to a large extent the same, and there is some economy of cost on that account. Be this as it may, the manufacture of starch holds an important place in the list of British industries, and gives employment to the sisters of the lads whose lives are spent in the health-giving occupation of fabricating tins of mustard. For starch packing is essentially woman's work, after the first heavy processes have been completed, and the story affords another example of the extraordinary lengths to which the specialisation of modern labour is carried. Before a penny box of starch can be placed upon the counter a hundred hands, each performing a separate duty, have been employed upon it.

Starch is the heat-giving substance which forms a large percentage of most food-grains. It contributes 85 per cent. to the bulk of tapioca, 80 per cent. of rice, 70 per cent. of wheat, 65 per cent. of maize, and even 15 per cent. of the potato tuber. From the first of these arrowroot is made, from the third household flour, from the second and fourth cornflour; but in commercial language the word starch is not applied to foodstuffs, being reserved for the forms of starch which are

Photo: Cassell & Co., Ltd.

GIRLS FILLING PENNY TINS OF MUSTARD.

used in the arts. Thus potato starch, under the name of farina, is largely employed as a medium for the stiffening of calicoes, and as an admixture with the dye-stuffs which are employed in calico printing. By a simple process of torrefaction it is converted into "British gum," and in that form is applied to the backs of postage stamps and the flaps of envelopes. But it is of starch as a laundry preparation that this article is designed to treat, and the substances turned to account for that purpose are almost as varied. Thus Belfast has specialised in the production of wheaten starch, Paisley in that of maize starch, and Norwich in that of rice starch. Germany, however, pins its faith to the potato, and there is in France a considerable manufacture of starch from the chestnut, which reaches this country from that ingenious land in the more toothsome form of the *marron glacé*.

The invention of starch as a dressing for fine linen seems to belong of right to a Continental genius. Its origin goes back to the misty days of the Plantagenets, and it was not until Mary came to the throne that a Flemish lady crossed the Channel in order to show the good dames of London town how ruffs ought to be starched. In those days the starch was of a yellowish hue, and the profession of starching flourished exceedingly in the spacious days of Elizabeth, whose ruffs cost a fortune to laundry. Then it fell on a day that one Mistress Anne Turner, who was concerned in the poisoning of Sir Thomas Overbury, went to the scaffold in all the bravado of a huge ruff. On this account, in 1615, the women of England turned their backs for ever upon an article of attire with such unpleasant associations, and the days of ruffs were over. But throughout the Puritan period the art of the starcher continued, the Roundheads being very partial to blue starch for their dainty collarets, and ever since, while fashions have come and gone, the demand for starch has grown with the years, until to-day its manufacture gives employment to a larger number of people than ever before.

The earlier stages in the preparation of starch are those through which all food-grains pass, and comprise the winnowing of the grain, and the removal of the epidermis by means of decorticating mills. Much of this work is now done at the port of shipment, especially in the case of East Indian rice, the employment of which for the production of laundry starch is increasing relatively by

leaps and bounds. First steeped in water for the purpose of being softened, a process which is in some instances accelerated by the use of a weak caustic lye, the grain swells and becomes fit to be deprived of its gluten, the sticky ingredient of the seed, which is at the proper stage floated away and dried into cakes as a food for swine.

This separation, however, is preceded by the process of grinding between mill stones, with the result that the material assumes a cream-like form, in which state it is pumped into vats, in whose sides are inserted glazed windows through which the condition of the various strata of the mass can be inspected. Water being added, the whole mass is agitated, and the starchy particles are held in suspension in the water, just as chalk would be if it were treated in the same way. At this point it is drawn off into settling tanks, and being allowed to settle there comes a time when it is ready to be dug out and packed in the form of small lumps into huge calico-lined boxes. Agitation being once more set up, the starch is reduced to a liquid form by virtue of its inherent moisture, and the application of the tender mercies of an hydraulic press removes the moisture, and leaves the mass dry and solid. It is now sawn into cubes about 4 lb. in weight, hardened for a day or two in a stove at a temperature of 170° Fahr., scraped free from its outer crust—the work often of girls—wrapped in paper, and restoved for weeks at a time in ovens, each of which frequently contains about a dozen tons. The bundles are at length removed to flat tables, and scarcely a touch is required to cause the cube, apparently a mass of glittering indestructible rock, to fall to fragments, in the strange crystaline forms in which starch is known to the washerwoman.

The packing of starch for sale is essentially the work of deft, tireless women. One of them seizes a heap of straw boards and feeds a machine which swiftly cuts them into shape, and at the same time scores them halfway through with the invisible lines with whose aid the four sides of the box are formed. The making of the box, with its inside lining, its top, its label, and so forth, is the labour of a dozen specialists. When dry

INTERIOR OF STARCH HOUSE.

Photo: Cassell & Co., Ltd.

MAKING STARCH BOXES.

the boxes are removed to the department in which they are filled with starch. For this purpose one girl weighs out the proper quantity, another fits it into the box, a third checks the weight of the filled box, another pastes the strip, which is placed in position by a colleague. A similar course is pursued when starch is packed in paper parcels for laundries, when it is packed in wood boxes in bulk for export, and so forth. The celerity which is attained by long practice in the performance of simple acts may be illustrated by the fact that one girl is able to put together the bodies of no less than 2,300 starch boxes every day of the week.

The spectacle of a mustard and starch factory, such as that of Messrs. J. and J. Colman Limited, of Norwich, with its hundreds of separate acts, is impressive in the extreme. This well-managed factory, which was visited for the purpose of this article, resembles a complex army, and the virtues of precision and disciplined routine are of paramount importance. In such an industry there is no room for the performance of auxiliary duties at home, and the operations are more completely centred in the factory than in the metal industries. It is in such factories that the amicable adjustment of interests between capital and labour is of supreme importance, and this is why these branches of manufacture afford to the industrial world an excellent example of the supremacy attained by Great Britain over her rivals in other parts of the universe.

E. G. HARMER.

Photo: Cassell & Co., Ltd.

FILLING STARCH BOXES.

FIREMEN OF THE BRITISH ISLES.

WHEN the Great Fire of London occurred, during the first week of September in the memorable year 1666, the only appliances for the extinction of fire were a few buckets and brass squirts, worked by hand. Water engines had been invented 1,800 years before, and at that very time there existed in the city of Nuremberg a horse engine which, with the aid of twenty-eight men, was capable of throwing an inch jet to a height of 80 feet. But it was not until four years after the Great Fire that a Dutch engineer invented the suction pipe and hose. The seventeenth century had almost expired before an enterprising insurance company—the famous Hand-in-Hand Office — determined to take measures to protect itself against serious losses by establishing a fire brigade of its own. Another century elapsed before a regular fire watch was organised in London, and in 1832 the brigades belonging to the insurance companies were combined into the London Fire-engine Establishment, and placed under the charge of the heroic James Braidwood, who lost his life in the terrible Tooley Street fire of 1861. Four years after that disaster the establishment was taken over by the Metropolitan Board of Works, and in 1889 by the London County Council. The number of men employed by the insurance companies in 1832 was 80; the fire staff of the brigade in 1901 was 1,136.

The Metropolitan Fire Brigade has served as a model and training ground for most of the brigades now scattered throughout the kingdom. Some account of its administration is therefore essential to a proper understanding of the question how firemen are made.

Candidates for appointment as firemen must not be more than thirty years of age, must have a chest measurement of not less than 37 inches, a height of not less than 5 feet 5 inches, and a record of continuous employment since their seventeenth year. It was formerly a rule that they must be seamen, but the rule is not now enforced, in order to give stalwart and agile artisans an opportunity of entering the service if they can prove themselves to be capable. It is the experience of the authorities, however, that a maritime training is the best, and of the present strength of the Brigade no less than 335 men have served in the Royal Navy, while of the remainder the greater number have spent their early years in the mercantile marine. In some provincial brigades, especially in the Midland districts, it is found that

Photo: Gregory & Co., Strand.

FIREMEN AT DRILL. DROPPING INTO THE SHEET.

members of the building trades make excellent firemen, because of their familiarity with building construction and their agility in mounting scaffolding. A large number of provincial brigades are branches of the local police, and for this reason a good many firemen throughout the country are landsmen by origin, and in many instances are drawn from the agricultural classes. But of this later.

The routine of the drill class is no child's play. By eight o'clock each morning the recruits have already done an hour of cleaning work. After forty-five minutes allotted to breakfast, the whole morning is occupied in instruction, drill, and cleaning, with the exception of a quarter of an hour of standing easy. After dinner, two hours and a quarter are spent in further drill; and in the evening the practical class engages in evolutions, the theoretical class being an eager and critical audience. At ten o'clock all lights are turned down. The routine of the men on duty at the stations covers the same hours, and every minute is occupied, even if it be only with the duty of standing by in readiness to spring up at the tinkling of a bell and to hasten off to the scene of a conflagration. In the Glasgow Fire Brigade practical joking is punishable by fine, all members must subscribe to the library, and no games are permitted in the stations before seven o'clock in the evening or before four o'clock on Saturdays.

Under the London County Council the pay of firemen under instruction is 24s. per week. It rises through the four grades to 37s. 6d. per week in the case of a first-class fireman; and the pay of a superintendent may reach a maximum of £295, inclusive of the estimated value of rent, coals, and gas. After fifteen years' service a fireman may obtain a life pension reckoned at 30 per cent. of his pay, and should he complete twenty-eight years of service he receives a pension of two-thirds of his pay. The widow of a first-class fireman who is killed in the discharge of his duty receives a pension of £20 per annum, with 1s. 6d. per week for each child until it is fifteen years old. There is also a scale of gratuities based upon length of service. The amount paid in pensions during 1901-2 was £13,907, and it is significant that among the 179 persons upon the list only nine were widows and six children.

RESCUE DRILL AT HEADQUARTERS.

London has always been fortunate in the men to whom the supreme control of its fire service has been entrusted. To mention no others, the names of James Braidwood and

Sir Eyre Massey Shaw are familiar throughout the world as names of officers who have brought to the discharge of their tasks unbounded enthusiasm and resource. By them, at any rate, the duty of fighting the flames was never treated as an opportunity for the display of mere physical courage. It was always that, but more and more it is realised that the protection of life and property from the fire demon requires brain and thought and patient organisation, without which the fire fighters would be powerless in the presence of a pitiless foe. Even the simplest drill books contain information about the laws of matter—about vacuums, latent heat, hydrostatics, the properties of air, the meaning of the co-efficient of expansion, and a maze of chemical and mechanical detail which must be studied by all those who desire to rise in their profession. Your sound fireman must not only be able to mount a tottering ladder, he must know something about the construction and materials of buildings; not only must he be ready to stand in a fierce blast, but be acquainted with the theory of steam. In many instances the risk of fire would be far greater but for the practical advice which is given by a fire officer when new factories or theatres are being built; and the true aim of such a man is not to figure in a roaring fire, but to reduce the number of fires more and more every year. Fire protection is very different from fire extinction; it is less heroic, less conspicuous, but it is of infinitely greater importance to the State.

Photo: Gregory & Co., Strand.

A TYPICAL LONDON FIREMAN.

OFF TO A NEW STATION. *Photo: Gregory & Co., Strand.*

This is an account of the human side of firemanship, but it will help us to understand the tremendous forces at the disposal of the metropolitan service to mention that the staff have within their reach 73 steam fire engines,

21 manuals, 40 miles of hose, 104 hose carts, 174 escapes, 55 ladder vans, 260 horses, 275 telephone lines, and 694 alarm calls. A canteen van for the refreshment of the brigade on heavy days is a recent innovation; and barges, tugs, floats, bicycles, and a hundred and one other appliances are available for service on land and water. With the improved water supplies of the large towns the need for powerful engines is less than it would otherwise have been, and it is not the least arduous of the duties of the brigade to subject the 26,097 hydrants within the 117 miles of the metropolitan area to a rigid scrutiny. Owing to difficulties of gravitation the pressure in the mains in London is less than in some other cities and towns. Thus Huddersfield has a night pressure of 160 lb., Bradford 140 lb., Edinburgh, Glasgow, and Manchester 100 lb., and so on, whereas London does not exceed a nominal 70 lb. In some of these industrial centres the high pressure permits of sprinklers being fixed in the ceilings of the factories, and whenever the temperature rises above a certain minimum the valves are automatically released. Such a system is not so ready of adaptation to the needs of London, although it has been adopted in many factories, and for the highest buildings the most powerful engines are requisitioned.

All these appliances have to be studied and cleaned and repaired from hour to hour, and a peaceful day of drill is often more tiring than one on which disastrous fires spring up in every quarter of the city. Each man is expected to familiarise himself with the duties of his immediate superior, so as to be able to take his place in a sudden emergency; and the record of the men is carefully followed by the superior officers, in order to make the best appointments when vacancies occur. In this service it is merit that wins the race, and the *esprit* of the corps is such that each member realises instinctively that he is the master of his own fate.

It almost invariably happens that the appliances sent to a fire are in excess of the actual requirements. Of the number of fires attended by the metropolitan brigade in 1901 only 99 out of a total of 3,684 were classed as serious. The Holborn station sent steamers no less than 463 times during the year, but only 21 were used. The number of historic fires is happily small, largely owing to the great celerity with which conflagrations are tackled in their early stages. It is only on rare occasions that a pitched battle is fought with the devouring element. At the fire in Finsbury in the summer of 1894 a force of 256 men had at their disposal 41 steamers, 14 manuals, 2 hydrants, a water tower, and 15 escapes. At Cripplegate in November, 1897, the number of men was 294, with 51 steamers, and the quantity of water used was estimated to reach the total of 15,000,000 gallons. Water was being played upon the ruins seventeen days after the outbreak occurred.

The arrangements for the prompt extinction of fires throughout the kingdom are by no means so complete as they might be. The whole question was examined by a Select Committee of the House of Commons, and the evidence collected served to show that in many important centres of population there are practically no efficient appliances at all. Out of 1,025 urban districts in England alone, at least 262 admitted that they had no brigades, and many existing brigades are little more than a name. Provincial brigades may be classed as paid, part paid, voluntary, and private. Paid brigades are formed either o civilians or of police, and the important part that is taken by the police force in the boroughs may be gauged from the fact that out of the 13,511 men forming the borough police of England and Wales, 132 are wholly employed, and 1,263 are partly employed, in the fire service of their own localities. Thus there are 1,900 policemen in Liverpool, of whom 55 perform no duties except those of the fire brigade, while 357 others come up for a month's fire duty—18 at a time, at intervals of about twenty months. By this means there is always a large reserve force of constables with a technical fire training, who are available for emergencies. These fire policemen receive 2s. per week extra pay in acknowledgment of their special training, as well as a small additional sum, beginning with 2s. for the first hour, for any fires that are attended by them in this capacity. So also at Portsmouth 19 policemen are told off for permanent fire duty, and the whole constabulary force is also trained in sections as

HEADQUARTERS OF THE LONDON FIRE BRIGADE.

a reserve. At Cardiff 26 constables have a special training, and are therefore available when required to go to the assistance of the permanent brigade, which in that case consists of a dozen civilians. Other cities and towns have adopted the same system of a police reserve, including Bristol, Norwich, Nottingham, and Sunderland. The Manchester brigade of 100 men is entirely civilian, and has no such relationship to the police, being in that respect modelled upon the metropolitan system. Glasgow also has its independent fire staff, a body of 124 picked men, each of whom must have had previous experience in a handicraft, and it is a justifiable pride with which their chief points to the fact that he has attended nearly six thousand fires with his brigade without losing the life of a single man.

At Exeter a still less expensive system is adopted. There are only two permanent officers, and the rank and file consists of a body of mechanics employed by the municipality. They receive a retaining fee of two guineas per annum, and a small payment for each fire attended. A few police are also in reserve. At Newport (Mon.) the chief officer of the brigade is a solicitor, and the mechanics who serve under him receive no retainer, but only their honorarium for work done. The same plan is adopted at Llanelly, except that here the brigade contains a leaven of seamen within its ranks. An excellent example of a voluntary brigade is to be seen at Pembroke, where there is a company of a dozen drilled men, who have no engine, but rely entirely upon a couple of hoses. The Rickmansworth brigade is also voluntary, the chief officer being a medical man and a justice of the peace. His force consists of thirty men, and they have no less than three engines, one of them worked by steam The Teddington brigade obtains no funds except such as are contributed voluntarily or obtained from the owners or insurers of property that has been saved.

PRESENTATION OF MEDALS TO FIREMEN.

All over the country there exist elaborate organisations within docks, factories, asylums, and other large institutions for the extinction of fire by private effort. As these lines were being written a fire broke out within Marlborough House, and it was promptly attacked

by the private brigade formed of the royal domestics. The fire precautions at Buckingham Palace and Windsor Castle are on a still more elaborate scale, each man having his recognised station, to which he repairs without delay upon the least alarm. One of the most interesting developments of private fire brigade training is to be found at Newnham College. Each of the three halls has its own divisional brigade, with a captain, two lieutenants, and sixteen members, and the women students are able to point with satisfaction to the fact that they have been able to extinguish two fires within their own domain without help from outside. They have no engine, as the hydrants within each hall suffice for all emergencies, and the fire drill is an interesting and attractive physical exercise on its own account, apart from its ulterior object.

It has been estimated that the total annual loss from fire throughout the world averages the huge sum of £45,000,000. Of this it is generally said that a fourth represents the loss in the United Kingdom alone, and the importance of fire fighting as a national industry will thus be clearly seen. The expert officials are desirous of some reform of the statute law, in order to improve the status of firemen and to relieve them of some disabilities. Thus, with respect to the damage done by voluntary brigades when engaged in fire extinction, the law does not protect them from the liability to an action for indemnity. The use of the brigade uniform and helmet by bogus brigades should be forbidden in the same way as the unauthorised use of the Army and Navy uniform. It is believed that firemen would welcome the possession of a badge of efficiency, conferred after an independent inspection. And the liability to be called off at a critical time to perform jury service is another anomaly which experienced officers wish to get altered. As the local bodies, which are still in the infancy of their work, settle down to the serious duties of reform, the imperfections which at present abound in many parts of the realm will gradually be removed. In no direction is this more needed to be done promptly than in that of guarding the national wealth against the insidious foe to combat which the firemen and their appliances were called into existence.

Brian Morris.

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THE LONDON COUNTY COUNCIL'S FIRE FLOAT *ALPHA*.

THE MAKING OF BIG GUNS.

FOR the big guns which bristle menacingly from the turrets of her ships of war, or grimly stand guard on her fortress ramparts, Great Britain depends on three big ordnance works—the Government Arsenal at Woolwich, the great Elswick factory on the banks of the Tyne, and the growing works of Vickers, Sons and Maxim at Barrow in Furness. Another establishment there is, that founded by Joseph Whitworth at Openshaw, Manchester, but it has been amalgamated with the larger concern at Elswick, to which it is now auxiliary, and under whose name and management it is carried on. Openshaw and Barrow produce chiefly quick firing machine guns of special design and of relatively small size, such as the Maxim, the Gatling, and the Whitworth, together with torpedoes and armour plate; it is from Woolwich and Elswick that the nation's heavy ordnance is mainly turned out.

It is an impressive and almost a bewildering sight to see, as the writer has seen, the nation's guns in the making at Elswick, the premier ordnance manufactory. It is a sight that monarchs, potentates, and ambassadors from every clime have travelled far to see. Elswick is famous for its entertainment of the world's notabilities who visit Britain's shores. Shahs from Persia, princes from India, nobles from China and Japan, crowned heads from European States, and uncrowned presidents from American republics, learned societies, and royal pleasure parties have held it a privilege to pass through its maze of shops teeming with human life, reverberating with the shriek of steam, the clang of hammers, and the whirr of machinery, and there witness the manifold processes through which modern ordnance passes in its evolution from the molten metal to the bright burnished gun complete in all its intricate parts, and ready at the instant call of the gunner to hurl its death-dealing missile far beyond the range of human vision. You may pass from shop to shop, until you have walked three miles or more, until your ears are deafened by the ceaseless buzz of machinery, until your eyes are dazed with glowing furnace and revolving shafts and cranks, until the senses deaden, and the mind reels in the effort to grasp it all. From the steel works, where the huge ingot of steel comes glowing at white heat from the furnace to meet the irresistible grip of the 6,000-ton pressure hydraulic press, to the delivery shop, where the finished gun awaits the firing tests, all is order and design, as precise in the smallest minutiæ as comprehensive in the general scheme. Huge boring machines bore an absolutely flawless steel gun-barrel weighing

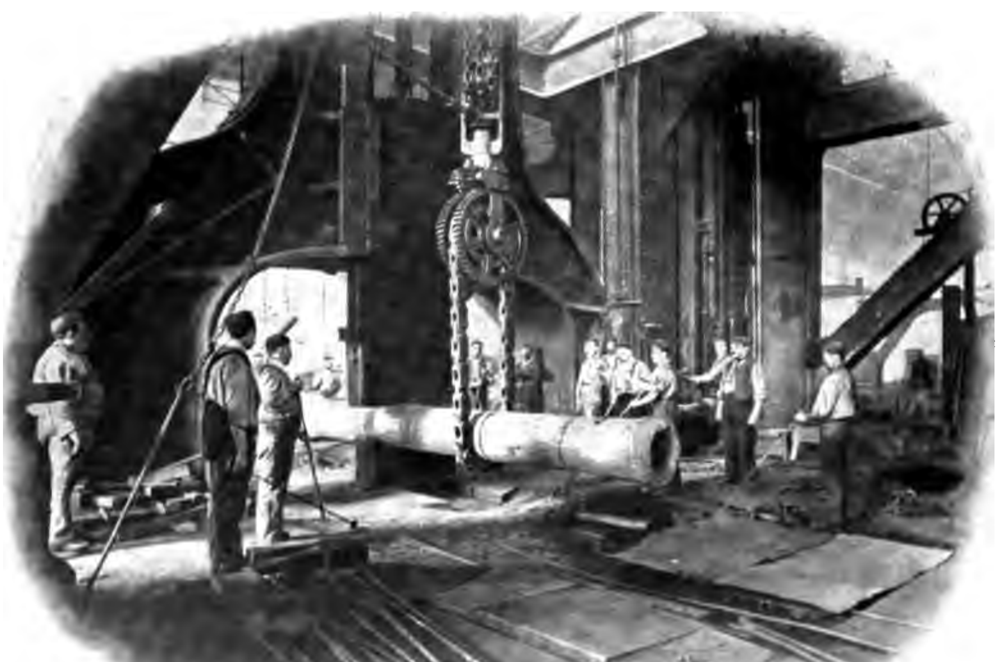
HYDRAULIC FORGING PRESS.

(From a photograph supplied by Sir W. G. Armstrong, Whitworth & Co., Ltd.)

up to 40 tons to the fineness of a 1,000th part of an inch. A titanic gun, whose projectile will devastate a city, is built up with a watchmaker's skill. The visitor leaves the works with an overwhelming sense of their tremendous energy, and a profound impression of their creator's genius; but the central idea he carries away is the perfect union of strength and precision which he sees everywhere around him. The ordnance works are infinitely great and infinitely little, and if genius is the art of taking pains then the gun-maker is the greatest genius of us all.

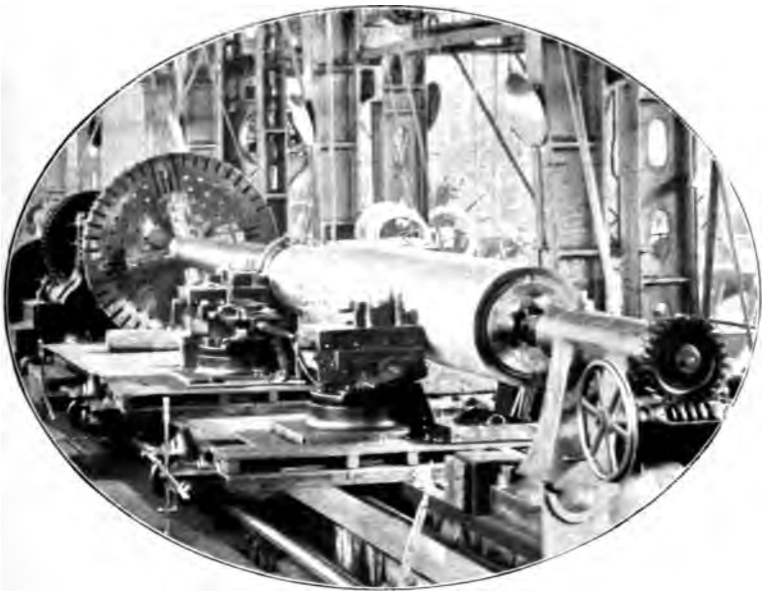
At Elswick over fifty large shops (including the steel works) are devoted to the making of guns, these shops covering over fifty acres, employing a busy army of from 15,000 to 16,000 men, and turning out an average of eighty-five guns of all sizes and types per month, besides mountings, carriages, turrets, and ammunition. The enormous value of this work may be judged from the fact that a 50-ton gun is worth more than £10,000, and the mountings as much more.

Like the battleship for which it is intended, like all things great and strong, the modern big gun is of slow growth. Its parts pass through almost incomprehensible stages in the process and manufacture, and are subjected to test after test, and then are slowly, and with the utmost care, pieced together, only to be subjected to more tests before finally leaving the makers' hands. It takes from ten to twelve months to make a 12-inch Armstrong gun. Its birth begins in the melting-furnace, where Siemens-Martin steel of the finest quality is subtly compounded of the best Swedish iron, rich oxide ore, and ferro-manganese, and emptied, molten and glowing, into a great casting ladle, from which it runs into the moulds, and is slowly cooled into ingots of from 20 to 40 tons. The ingot from which the barrel of a 12-inch gun is made weighs over 40 tons. Measuring 13 or 14 feet in length when it comes from the furnace, a hole is bored through it, and it is then compressed and drawn out in the powerful hydraulic press which works up to 6,000 tons pressure, until it measures three or four times that length. Before the elongated ingot leaves the steel works it is rough-turned in a heavy turning machine, and, most important detail, a disc is cut off



FORGING A GUN TUBE.

(From a photograph supplied by Messrs. Cammell & Sons, Ltd., Sheffield.)



ROUGH-TURNING A GUN-BARREL IN TURNING MACHINE.

(Photo supplied by Sir W. G. Armstrong, Whitworth & Co.)

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Before the hollow, rough-turned cylinder goes further, then, the steel discs cut from it are severely tested. Out of these discs there are cut several testing pieces about four inches long, with heads resembling short double-headed bolts, the hydraulic testing machine taking hold of the bolts at either end. The tests are made in a little office not far away, where stands a machine which does not take up much more space than a copying-press, but has tremendous power. The first duty of those conducting the tests is to note when the steel commences to move or yield as it begins to elongate under the stress to which it is subjected; then a piece is elongated until a point is reached when the steel ceases to return after expansion to its original length; and, finally, the breaking stress is ascertained by adding weight until a test piece breaks. A self-registering apparatus is attached to the bolts in the first two tests.

The first test shows that the steel began to move at a pressure of 15 tons to the square inch; the second proves that the amount of the strain which the steel will stand without permanent set is 21 tons per square inch — in the bolt two inches long the measure of elongation is found to be just under half an inch; and the third shows that it breaks at 36·3 tons per square inch. In the case of a big gun, say 50 tons, the minimum requirements of the Government are yielding strain 11 to 15 tons to the square inch; amount of elongation, above 15 per cent. of the length tested; and breaking strain between 27 and 35 tons per square inch. These tests refer to the steel in its soft state, as it comes from the steel works. Similar tests with other bolts follow, upon their being hardened by heat and tempered by being plunged into oil. At this last series of tests the minimum requirements for a similar gun are these: Yielding strain, 25 to 33 tons to the square inch; amount of elongation, above 10 per cent. of the length tested; and breaking strain, 38 to 48 tons per square inch.

Assuming that the tests are satisfactory, as they were when the writer saw them, the boring of the gun is the next operation. At the first "cut" 9½ inches are taken by a circular cutter out of the centre of the cylinder, which has an outside diameter of about 21 inches. With the barrel 30 feet long the rough boring occupies more than a week, although the machine works day and night. The borer or cutter, which is carried on the end of a substantial shaft, advances at the rate of 4¾ inches per hour, that is assuming it could be kept at work continuously, but, as a matter of fact, it is frequently withdrawn to admit of the examination of the bore and ensure the accuracy of the "cut." Although it has behind it a powerful pressure, and cuts the hardest steel like so much cheese, the bore travels silently, and with singular slowness. This slowness means economy and care. The slightest irregularity in the progress of the

borer over any part of the cylinder might easily mean the complete ruin of the ingot. Having been rough-bored, the barrel is toughened by being heated and tempered by being dipped in a pit of oil, operations naturally involving the use of heavy hydraulic cranes, which are all over the works. Then comes the difficult and tedious process of "fine-boring." The fine-boring comprises three separate borings, and in the case of a 12-inch or 50-ton gun the rough "cuts" in this stage take two or three weeks each. In the final boring from 700th to $\frac{1}{10}$th of an inch, according to the gun, is left to be taken out. This operation requires the greatest care. If the bore becomes torn or damaged by the breaking of a tool or seizure of the boring head, a barrel which may now be worth between £2,000 and £3,000 is utterly spoiled.

The barrel, having been fine-turned in the lathe on the outside, is ready to receive the outer coats of steel with which a gun is built up. A gun is really a succession of cylinders of steel shrunk over each other, and each cylinder has to be treated in almost exactly the same fashion as the barrel or central tube—that is to say, has to be tested, turned, rough- and fine-bored, and gauged carefully throughout, to ensure correctness of diameter. To attain perfect accuracy in all these borings is no easy matter, particularly in the case of the central tube, for as the cutter of the bore wears down as it approaches the end of the cylinder, the diameter of the tube diminishes. The 12-inch gun consists of five cylinders or layers, or four beyond the barrel. These cylinders run in thickness thus: Barrel, $4\frac{3}{4}$ in.; second course, 5 in.; third course, $3\frac{1}{4}$ in.; fourth course, $3\frac{1}{2}$ in.; fifth course, $4\frac{3}{4}$ in. The gun is thickest over the powder chamber—about $19\frac{1}{4}$ in.—because it is the seat of the explosion. In the guns made for our national service the barrel is covered from breech to muzzle with layers of wire or with long cylinders of steel, the muzzle being finished off with the old-fashioned muzzle-swell. In the older patterns of guns all the cylinders, except the inmost one, were in short lengths; the 110-ton gun comprises no fewer than forty-four pieces, apart from the breech-screw and the mechanism for closing it. The number of tests which this division of the gun into forty-four sections involves is striking enough. The barrel is credited with twelve tests for each end—24; the other 43 pieces have four test pieces taken from each end—344. Thus the total number of tests made in the case of each separate gun is 368.

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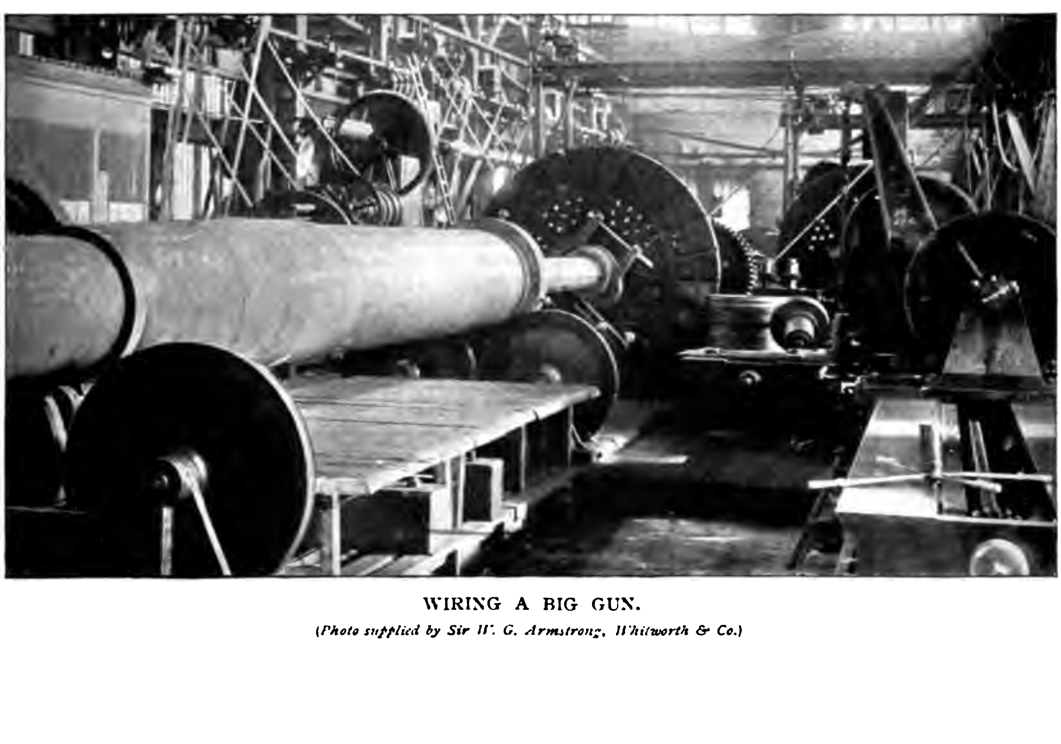

WIRING A BIG GUN.

(Photo supplied by Sir W. G. Armstrong, Whitworth & Co.)

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In a natural way the great strain following upon the explosion of the charge of powder would fall heaviest upon the inner cylinder (or barrel), in which the explosion takes place, and the outer cylinders would only experience it in a diminishing degree, in a degree which diminishes so rapidly, as it approaches the exterior part of the gun, that it might almost be said to have disappeared by the time it reaches the outside parts, for, as it will be clear, there is a point under such circumstances where thickness ceases to add strength. By subdividing the gun into cylinders, each cylinder having been put into a high state of tension by being shrunk on, brings the full measure of its power to withstand strain to the support of the inner cylinder or bore, and the other parts of the gun, that is, each successive layer, reinforces the accumulated resisting power of the whole mass. A further consequence of the system of shrinking the cylinders one over the other is that the compression experienced by the original cylinder or barrel is so severe that the outer cylinders, owing to their being in a state of tension, first take the strain created by the explosion, and as the outer cylinders expand or extend (as the quality of metal guarantees that they will do), the strain is progressively imparted to the original tube, which ultimately receives its allotted proportion.

It was to further distribute the strain over the whole gun that the wire or steel riband gun was adopted at Elswick with such success. Great additional strength and security are gained in a gun through construction by means of ribands. The gun is also lighter than one built in the ordinary way. The building-up of a gun in riband minimises the danger from flaw, for even should a flaw escape observation when the riband is being bound on, it is confined to a small area, permits of the employment of steel of greater strength than is attainable in the ingot form, and secures more fully and efficiently than is possible in the usual form of manufacture the measure of tension in the steel. If our gun is a wire gun, then, which it is nowadays pretty certain to be, the process of wiring must begin when the first steel cylinder barrel is so far finished as to be ready for its jacket. Before that is shrunk on, the wiring has to be done. The riband, which is apparently rather more than a quarter of an inch broad and not half that thickness, is wound on cold from a drum. The gun, revolving slowly, draws the riband from the drum, while the drum is controlled by a brake to ensure that the wire is brought into a full state of tension. The strain varies with each layer of riband, these strains being determined by the brake apparatus attached to the drum shaft, which regulates the amount of tension required for each successive layer. In the 10-inch gun there are fourteen layers of riband. The riband portion of the gun is covered by a casing of steel. The 10-inch riband gun has a thickness of walls of 11 inches, of which 3 inches is of steel riband. In some of the larger guns as much as 100 miles of riband are coiled up between its cylinders.

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Photo: Cassell & Co., Ltd.

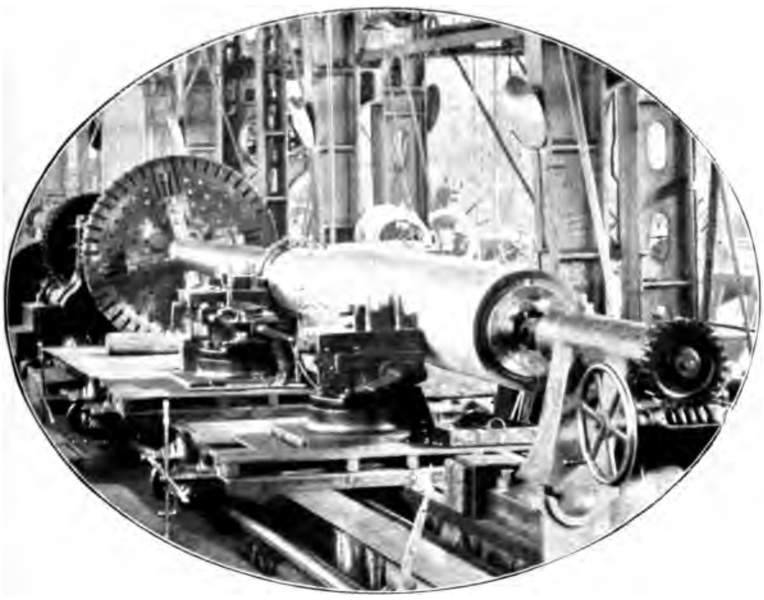
THE GREAT CRANE AT WOOLWICH.

THE MAKING OF BIG GUNS.

FOR the big guns which bristle menacingly from the turrets of her ships of war or grimly stand guard on her fortress ramparts, Great Britain depends on three English ordnance works—the Government Arsenal at Woolwich, the great Elswick factory on the banks of the Tyne, and the growing works of Vickers, Sons and Maxim at Barrow in Furness. Another establishment there is, that founded by Joseph Whitworth at Openshaw, Manchester but it has been amalgamated with the larger concern at Elswick, to which it is now auxiliary, and under whose name and management it is carried on. Openshaw and Barrow produce chiefly quick-firing machine guns of special design and of relatively small size, such as the Maxim, the Gatling, and the Whitworth, together with torpedoes and armour plate; it is from Woolwich and Elswick that the nation's heavy ordnance is mainly turned out.


HYDRAULIC FORGING PRESS.
(From a photograph supplied by Sir W. G. Armstrong, Whitworth & Co., Ltd.)

It is an impressive and almost a bewildering sight to see, as the writer has seen, the nation's guns in the making at Elswick, the premier ordnance manufactory. It is a sight that monarchs, potentates, and ambassadors from every clime have travelled far to see. Elswick is famous for its entertainment of the world's notabilities who visit Britain's shores. Shahs from Persia, princes from India, nobles from China and Japan, crowned heads from European States, and uncrowned presidents from American republics, learned societies, and royal pleasure parties have held it a privilege to pass through its maze of shops teeming with human life, reverberating with the shriek of steam, the clang of hammers, and the whirr of machinery, and there witness the manifold processes through which modern ordnance passes in its evolution from the molten metal to the bright burnished gun complete in all its intricate parts, and ready at the instant call of the gunner to hurl its death-dealing missile far beyond the range of human vision. You may pass from shop to shop, until you have walked three miles or more, until your ears are deafened by the ceaseless buzz of machinery, until your eyes are dazed with glowing furnace and revolving shafts and cranks, until the senses deaden, and the mind reels in the effort to grasp it all. From the steel works, where the huge ingot of steel comes glowing at white heat from the furnace to meet the irresistible grip of the 6,000-ton pressure hydraulic press, to the delivery shop, where the finished gun awaits the firing tests, all is order and design, as precise in the smallest minutiæ as comprehensive in the general scheme. Huge boring machines bore an absolutely flawless steel gun-barrel weighing



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Before the hollow, rough-turned cylinder goes further, then, the steel discs cut from it are severely tested. Out of these discs there are cut several testing pieces about four inches long, with heads resembling short double-headed bolts, the hydraulic testing machine taking hold of the bolts at either end. The tests are made in a little office not far away, where stands a machine which does not take up much more space than a copying-press, but has tremendous power. The first duty of those conducting the tests is to note when the steel commences to move or yield as it begins to elongate under the stress to which it is subjected; then a piece is elongated until a point is reached when the steel ceases to return after expansion to its original length; and, finally, the breaking stress is ascertained by adding weight until a test piece breaks. A self-registering apparatus is attached to the bolts in the first two tests.

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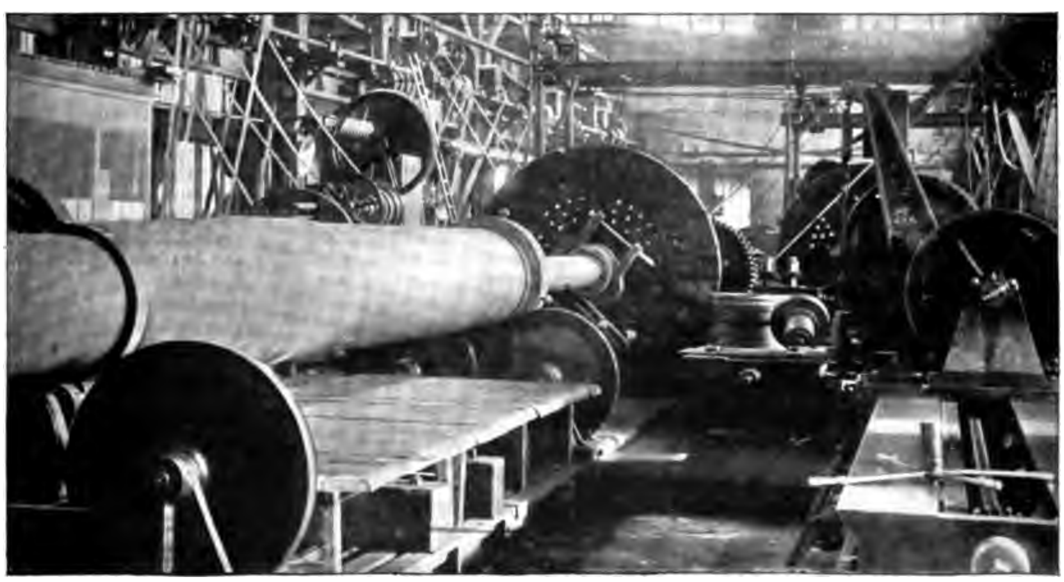

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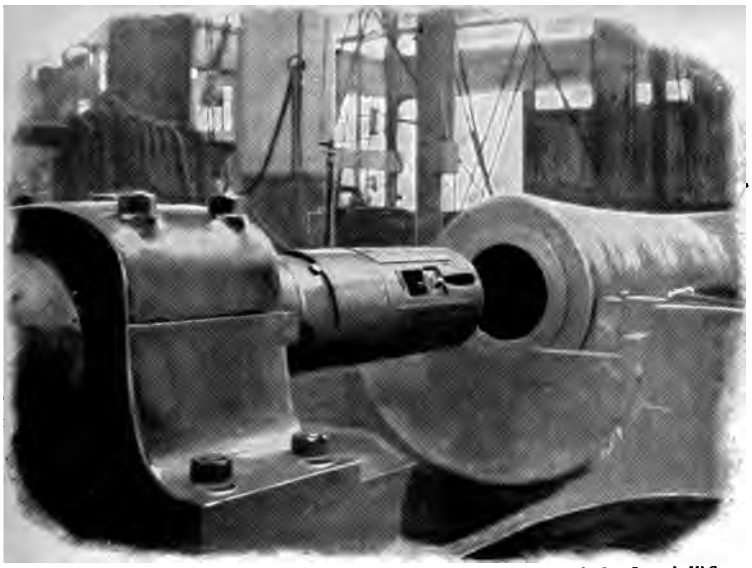


Photo: Gregory & Co., Strand, W.C.

A WIRED GUN PLACED IN POSITION FOR RIFLING.

occupies a week to a month, according to size, with the machine working continuously. The pitch of the rifling is progressive, and with a 43-ton gun the cutter will make one turn in every 30 feet. The cutter—which only cuts in coming out — goes up each groove from eight to twelve times, according to the hardness of the metal, and, as there are eighty grooves, in many instances it travels along the gun eight hundred times. The greatest conceivable care has to be exercised in the rifling of big guns, as the slightest departure from the true course may now destroy material and work worth together £10,000 or £12,000.

The gun now remains to be "chambered" and fitted with the breech-screw. The chamber, which is enlarged by a subsequent boring after the bore is completed, is bottle-shaped; it does not meet the bore abruptly, but the two diameters are joined by easy curves. The gunmaker seeks to avoid a long chamber, as it gives scope for wave action on the part of the powder-gas, with the result that excessive local pressures are created. The breech-piece of the big gun is connected with the breech-end of the gun by a hinged platform. The breech-piece or breech-screw of the 110-ton gun draws out from the gun on to a sliding tray. In all cases the breech-screw or breech-plug is fastened in the breech-end of the guns upon what is known as the interrupted screw system, that is, the breech-plug and the breech-end of the gun are cut into corresponding screw-grooves, only for these to be subsequently taken out to the extent of one-half in opposite quarter-sections, so that the breech-piece is easily pushed into the gun—the screw parts of the breech-piece passing into the indented sections of the breech-end, and *vice versâ*—and the screws drawn into each other by a lever. The interrupted screw is really an ingenious form of lock. The screw in our gun is 18 to 20 inches long.

The fixing of the breech-piece demands great skill. The precision of the fit is a vital point. It is an absolute necessity to prevent the escape of the powder-gas from the powder-chamber through the breech-pieces. The escape of gas through the breech is prevented in this way: An annular canvas bag, filled with asbestos and suet, is placed between the front of the breech-screw and a strong steel bolt shaped like a mushroom and called from its shape "the mushroom head." When the gun is fired the pressure of the powder-gas forces the mushroom head back, compresses the canvas pad, and squeezing it outwards makes it bear closely against the interior of the gun, so that an escape of gas is impossible; when the projectile is clear of the gun, and the pressure is removed, the pad returns to its original condition by its own elasticity, and the breech-screw is easily withdrawn. The effectual closing of the breech so as to prevent the escape of gas has long been a problem whose difficulty is only surpassed by its importance, for it must be remembered that the powder-gas exerts the same enormous pressure upon the breech-piece as it does upon the projectile; but that the Elswick Company have hit upon an efficient method is sufficiently proved by the fact that the British service guns are fitted on the same principle.

The arrangements for firing the gun appear to be simple, but as a matter of fact

they are carefully elaborate, for unless several levers each lie in a particular way it is impossible for the needle-hammer to strike the needle, or for the needle to strike the primer. The small primer-cartridge, which by its flash fires the great charge of powder, is ingeniously constructed so as to prevent the escape of gas. It is a close-ended tube, and, the metal being flexible, the cap, which is inside, is fired by the striker without any hole being made through the base of the cartridge. This close cartridge was introduced by the Elswick Company. The gun is fired by the hammer at full cock, which, moved by a pull upon a lanyard, strikes the needle, the action of which fires the powder. In turrets the guns are fired by electricity by the commander, who, unlike those working the guns, is in full sight of the object of attack, but field guns are generally fired by hand.

Now completed, the gun, after an impression of its interior has been taken in gutta-percha, is ready for proof. Guns are almost continually being proved at a range which the Elswick Company possesses in the moorland district of Ridsdale, thirty-five miles north-west of Newcastle. Machine guns are tried on the moor adjoining the late Lord Armstrong's seat at Cragside, near Rothbury, forty miles from Newcastle, and experimental firing with big guns is carried on at a tidal range of four-and-a-half miles at Silloth, on the west coast. Only the guns ordered by the British Government go to their destination unproved. Of course, in the case of guns fitted to ships-of-war built at Elswick, special firing tests always constitute part of the trial trip to which the ship is subjected before being duly handed over to her owners. So, naturally, are guns fitted on his Majesty's ships before the ships are put in commission. And it is proof of the gunmakers' accuracy, whether at Elswick, Woolwich, or elsewhere, that these guns seldom fail in successfully passing their firing tests.

R. W. JOHNSON.

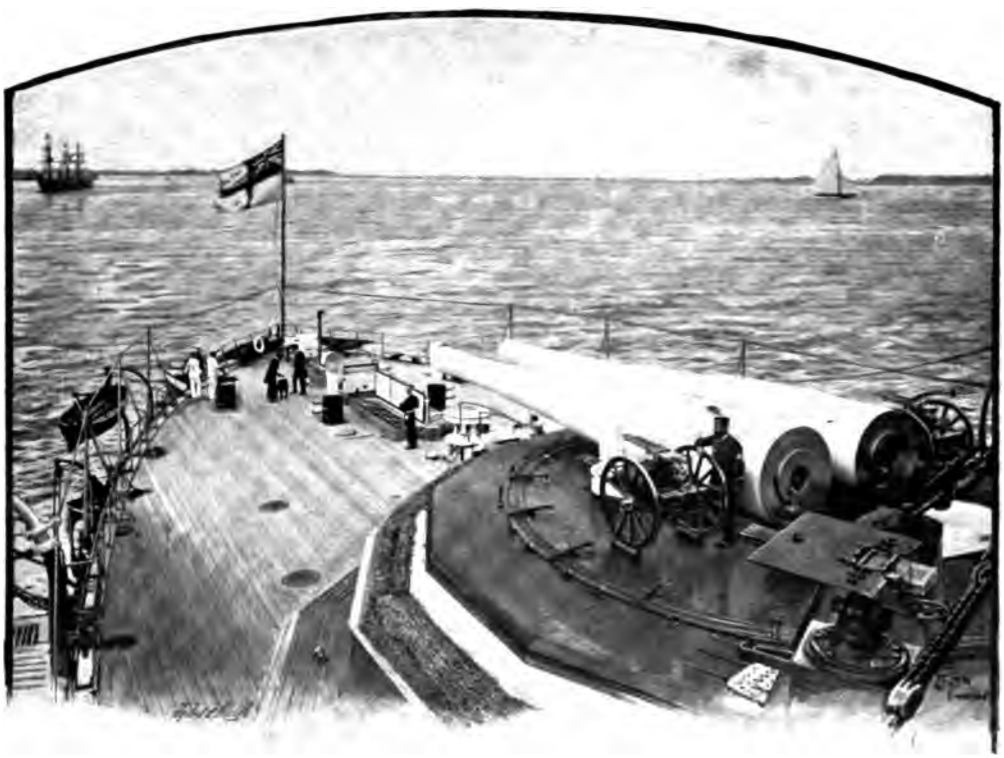


Photo: Gregory & Co., Strand, W.C.

AFTER BARBETTE OF H.M.S. *CAMPERDOWN*, SHOWING 67-TON GUNS AND MACHINE GUNS.

HOW MONEY IS COINED.

A VISIT TO THE ROYAL MINT.

IF you stand at the north end of the Tower Bridge, with your back to Father Thames, you will have the ancient Tower of London on your left hand and the outskirts of St. Katharine's Docks on the other. In front of you there rises a block of old-fashioned buildings, whose gates are guarded night and day by red-coated sentries. This is the Royal Mint, where all the money coined in England is made. Some of the operations by which money is coined are shown to privileged visitors at certain hours. But the number of people admitted at one time is only half a dozen, and in the course of the year less than 10,000 visitors enter their names in the book. For this reason the special photographs which we are privileged to publish will be welcomed with interest.

THE GOLD MELTING ROOM.

Leaving the Tower Hill, with its romantic associations, behind us, let us cross the road to the little postern gate, at which two police sentries are stationed. The neighbourhood, dingy as it now is, should be sacred in the eyes of every Englishman, because it is the oldest part of London. For centuries the spot upon which we are now standing was the site of the old abbey of Eastminster, which at one time was more famous than its great rival at Westminster. Until the beginning of the nineteenth century the minting of money had been carried on in London at the Tower ever since the time of the Romans themselves, but in 1811 the sum of £250,000 was voted for the purpose of erecting the Royal Mint, and since that time various changes have been made in the buildings to enable them to cope with the enormous and increasing demand for coins that comes from every part of the Empire year after year.

All this time, we will suppose, the police officer has been examining our credentials. We at length find ourselves in a spacious courtyard, neatly laid out with greenery. In the corners may be seen the official residences of the Deputy Master, the superintendent, the assayer, the chief clerk, and other officials who are always on the spot. The imposing structure in the centre contains the Mint Office, by which all the work of this curious colony of skilful artisans is regulated. The first thing to be done—on the principle of the famous Mrs. Glasse—is to catch your ore. This comes into the possession of the Mint in the shape of ingots, which at busy times arrive in vans two or three times a week. After running the gauntlet of the sentinels, the vans rattle over the cobble-stones of the courtyard to the main entrance. Through this the ingots pass, and after being weighed they are stored in the strong-room until they have been assayed.

The gold ingots, which all come from the Bank of England, weigh 400 ounces apiece, and there are times when the Mint has a little stock of 35 tons of gold to go on with. Silver ingots, on the other hand, weigh about 100 lb. each, and there may be a small matter of 20 tons in stock at a time. Copper is also required, but this does not always arrive in the form of ingots nowadays, but is delivered by a Birmingham factory in the form of blank discs, ready for stamping into bronze coins, of which the average production is a ton per day.

Every morning the chief officials have to decide what coins are to be made. Sometimes the Bank of England informs the Mint that it is running short of half-sovereigns; at another time there may be a demand from the Bank of South Africa for an extra supply of silver money. All these little points have to be taken into consideration, and the work is planned out accordingly. Let us suppose that sovereigns are to be made on a certain day. So much gold, with the proper proportion of alloy, is weighed out and delivered to the superintendent, who is responsible for passing it on from room to room, until he returns it again to the chief office in precisely the same weight of metal, but in the form of finished coins.

ROLLING FILLETS.

MARKING MACHINE.

His first care is to pass it on to the melting house. This is a sort of kitchen, with separate departments for gold and silver, and a staff of about sixteen men. A couple of ingots, with some of the waste gold left after the coins have been cut from the strips, are dropped into a blacklead crucible, which is then lowered into one of the eight furnaces that stand in a row. The gold and the copper are slowly melted until they have the appearance of so much dull coloured liquor. At the end of an hour the red-hot crucible is lifted by means of tongs, and the molten gold poured into eight or nine moulds, each of which produces a bar of the value of about £600. Each of the furnaces is therefore able to melt its little potful six times in the course of the day, and when the Mint is engaged upon this feast of Midas, it is able to turn out golden bars at the rate of a quarter of a million sterling every day. The same course is pursued when boiling silver, except that the blacklead saucepans used for this metal hold about 5,000 oz. apiece. No one could possibly lift such a weight. The silver crucibles, therefore, are picked up by an electric crane, which carries them round the melting house with startling

rapidity to the place where the moulds stand ready. Here they are tipped up at an angle that allows the glistening, fiery liquid to flow out of the lip of the crucible into the moulds, which one by one are pushed under the burning fountain.

If the men have stirred the materials well, the bars will by this time be of a uniform composition, the gold alloyed with one-twelfth of copper, the silver with three-fortieths. But the bars are not always homogeneous, and a fragment is cut from the first and last bar in each potful, to send to the assayer. If his report is unfavourable, it is melted all over again, and this happens about once in every twenty times. If, on the other hand, the bars are found to be up to the standard, they are cooled, smoothed over at the rough edges, and transferred once more to the huge balances, in which the metal that was first weighed on its entrance in the form of ingot is now weighed on its exit in the form of bars.

THE ANNEALING ROOM.

The next stage in the history of money-making is reached by the arrival of the bars in the rolling-room. Here a gauger, with a staff of ten assistants, takes possession of the bars, which may be of the thickness of half an inch, and passes them between a succession of powerful steel rollers. By this means they are gradually made longer and thinner, until at length they become thin fillets, slightly thicker than the coins for which they are intended. The first machine is called the breaking-down machine, and it receives each bar into its inexorable jaws ten times over. Four other machines carry on in succession the operation of thinning, but before a fillet is done with it has to endure the pressure of these tremendous rollers more than thirty times.

COINING PRESSES.

The strips of metal, which now look like the brass bands sometimes used for muslin window blinds, are by this time ready for the cutting room. First of all, they are submitted to the tender mercies of a pair of drags, which have been in use since the year 1816. By this machine the strips are dragged over and over again between two rollers, which give them an even thickness. Each strip is then taken to a cutting press, which punches circular discs out of it at the rate of 150 per minute. The discs hereupon are transferred to a machine, by which they are marked with a projecting rim, and are now ready for the annealing furnaces. After being raised to a cherry-red heat, they remain in these furnaces for a quarter of an hour at a temperature of about 1,600 degrees

Fahr., and are then cooled in water, washed, and thrown into beechwood sawdust, which is supplied by the chairmakers at High Wycombe.

The time has now arrived for the blank discs to be raised to the dignity of coins by being impressed with the portrait of the Sovereign, and with the other devices by which the coin is distinguished from all others of the same size, British or foreign, old or new. This part of the work is performed by twenty presses, worked by hydraulic power, and each attended by an alert operative, who feeds the discs into his machine at the rate of ten dozen per minute. This he does hour after hour for seven hours each day. Each press is able to stamp any coin, from a farthing to a £5 piece, with the exception of the crown, the peculiarity of which is that, instead of a "milled" edge, it is provided with an inscription round the rim. This is squeezed into the edge of the coin by means of a collar in three pieces, and for this purpose a special press, requiring the attention of two men, has to be used.

The coins are now taken away to the "ringer," as the boy is termed. He sits behind a glass partition, and there, taking up a handful of coins, allows them to fall individually upon a steel slab, and then, by the ring, detects any cracked or flawed coins.

The most delicate operation of all has still to be performed. The coins pass into the weighing room. Here they are passed down a tube into an automatic weighing machine, so tender and sensitive that it has to be protected from the slightest draught of air by being placed under a glass case. A sovereign is allowed to vary from the standard weight by a difference of one-fifth of a grain more or less, and the result of passing it under the critical eye—or rather finger—of the automatic balance is to throw it into one of three boxes, according to whether it is "good," light, or heavy. It is found by experience that only 2 per cent. of the silver pieces are above or below the standard weight allowed, whereas gold pieces to the number of 12 in every 100 have to be re-melted and passed through all the processes of coining over again.

THE COUNTING MACHINE.

The "good" money is taken out of the tills as fast as it is weighed. The gold coinage is now counted into £100 bags, and

taken to its stronghold, there to await its removal to the Bank of England for circulation all over the world. The silver and bronze coinage is counted by machinery. The coins are brought in bags to be taken up to the centre of the machine, and there received by the two men at the top, who empty the bags on to a sloping slab, the coins falling into a single channel or funnel, and there by their own weight revolve an interchangeable cog-wheel, which is inserted to suit the value of the coins to be counted. This wheel revolves so many times, according to the value of the coin, and when a hundred pounds' worth of silver has passed the wheel stops. When the man below has collected the coins in bags he releases the machine, and the operation is repeated.

One link in the chain still calls for a final word. The patterns which a[…] upon the two faces of a coin ar[…] by means of dies. These are mad[…] original matrix engraved by th[…] whom this responsible task is ent[…] only one matrix exists for ea[…] From this a punch is produced by[…] pressure in a die press, and the p[…] turn is used for the manufacture o[…] each of which is not able to st[…] than 70,000 pieces.

This, then, is a brief outlin[…] processes through which the man[…] of coins minted every year on T[…] have to pass, and it is not to be[…] at that in every part of the w[…] British sovereign is accepted as […] of sterling value, of unimpeachable[…] and of artistic excellence.

E. G. H[…]

(The illustrations accompanying this article are from photographs specially taken for the purpose, and a[…] copyright of Cassell and Co., Ltd.)

THE WEIGHING ROOM.

Photo: R. Welch, Belfast.

AN IRISH LACE CLASS, ARDARA.

THE MAKING OF LACE.

ONE OF THE MOST INTRICATE OF BRITAIN'S INDUSTRIES.

FEW industries appeal to women like the making of lace. The fabric is so delicate and fine, so gossamer-like, and yet so strong, and the tracings are so infinite in variety and beautiful in design, that woman regards the product of this manufacture as a perquisite of her sex. Man is allowed silk facings to his coat, he has linen handkerchiefs, and wears woollen socks, but after he is able to walk he rarely ever uses lace of any kind. On the other hand, it is most intimately associated with all the great occasions of his sister's life: it forms the principal ornamentation of baby's christening robe; it adds to her charms when later she enters church as a bride; in middle age it helps to throw back the years; and it is a lace cap which adorns granny's honoured head as her days draw gently to their close.

In various ways has the manufacture of lace been introduced into these islands. From Greece and the Ionian Isles, by way of Venice and Flanders, the art has come, but not always as a free gift. The secrets of such crafts are carefully guarded, and half a century ago, when Mother Smith, of the Presentation Convent at Youghal, conceived the idea of occupying the children under her care with this industry, she had to unravel designs thread by thread before she could solve the intricacies of their details.

The making of lace is the occupation of two distinct classes of workers, who labour under different conditions and in different parts of the country. Hand-made lace is the employment of women and girls, and is carried on in small country towns and villages, many of which are remote from the railroad and the busy world's whirl. According to a petition sent to Parliament a couple of hundred years ago, the lace manufacture of England was "the greatest next to the woollen," and maintained "a multitude of people," but it is now chiefly confined to the counties of Devonshire, Bedfordshire, Oxfordshire, and Buckinghamshire, and to several parts of Ireland.

Machine-made lace is localised in the county and district of Nottingham. There huge factories, many storeys high and built at the cost of many thousands of pounds, are busy night and day with the whirr and hum of immense machines which only men are allowed to work. Women and girls find

a place in the dressing and finishing operations, but so unusual are the conditions under which they labour, and so exacting the material over which they have charge, that Acts of Parliament have been specially modified for their benefit. It is impossible to say precisely how many people are employed in the industry, but the number may be put at 50,000, about half of whom, including some 9,000 men, are in the Nottingham district.

Considering first the manufacture of hand-made lace, it must be pointed out that here again there are two distinct kinds—needle-point, which in the United Kingdom is confined to Ireland, and pillow lace, the cottage industry of England. It is so named because the worker has a pillow, or cushion, stuffed with straw and covered with printed calico, upon her lap as support for the pins round which she entwines her thread. Upon the pillow is fastened a sheet of parchment, with the pattern duly traced and pricked over with pin-holes at every point where pins require to be inserted in the course of the work. There are also at hand a number of bobbins, now made of wood but formerly of fish bone, each provided with its quota of linen thread and attached to one of the pins. Starting from the first of these, the worker intertwists and crosses the thread by passing the bobbins round the pins and over and under each other. Thirty or forty bobbins are generally required for one pattern, but in the execution of the most elaborate kinds of Honiton, Bedfordshire, or Buckinghamshire lace as many as 1,000 may be necessary. The size of pillow used varies in the different lace-making counties, but the method of work is the same.

In old times the net as well as the flower, sprig, or "gimp" was made by hand, but nowadays the net comes from Nottingham, and generally sprigs only are hand-made. Lace-making has always been an ideal cottage industry: it can be carried on entirely at home, much or little can be done according to time and inclination, and the pillow can be laid down at will. The workers are able to add materially to the family resources, and during the hard winter of 1895, when the fisheries of Devonshire failed to support the husbands, the nimble fingers of the wives kept the homes together without the necessity of applying for relief. Old and young alike are to be seen at work in the picturesque gardens and ivy-covered porches, as well as in the numerous Lace Schools which have done so

DEVONSHIRE LACE MAKERS.

much to stimulate the industry. County Council classes are also now held in various places—some for grown-up people and others for children, as the earlier they learn the more proficient are they likely to become.

A different system prevails in Ireland. Pillows are here no longer needed ; the needle takes the place of the bobbin, and much of the work will be found to resemble embroidery. The modern development of the industry is to be traced back to the famines of fifty years ago, when the nuns of the Presentation Convent at Youghal, a little to the east of Cork and Queenstown, selected girls with a taste for fine needlework, and taught them to utilise their talent in lace-making. This district produces the famous "Irish point," and tourists from Glengariff to Killarney are often allowed to see the girls at work in the more public rooms of the convent, their fingers busy with the needle as if for dear life. The patterns are drawn out by the nuns in their private compartments and passed on to workers, numbering some fifty or sixty, under the charge of a sister of the convent. Though seemingly so light, the lace made by them possesses very great durability, and it is almost impossible to rip open the stitches.

Somewhat similar is the "rose point" of the convents of County Fermanagh, and many other districts of Ireland have their own particular variety, the work being done at home in the cottages as well as in the convents. We may especially note the tambour lace of Limerick, which is so called because the frame on which it is worked resembles a drum-head or tambourine. On this is stretched a piece of Nottingham net, and thread is drawn by a hooked, or tambour, needle through the meshes according to a design placed before the worker. Nothing comes amiss to the Irish lace-maker —Venetian point, Italian reticella work, Honiton pillow, and other specialities are all eagerly seized by the nuns to suggest to them new designs and ways of working.

DRAUGHTSMEN AT WORK DESIGNING LACE CURTAINS.

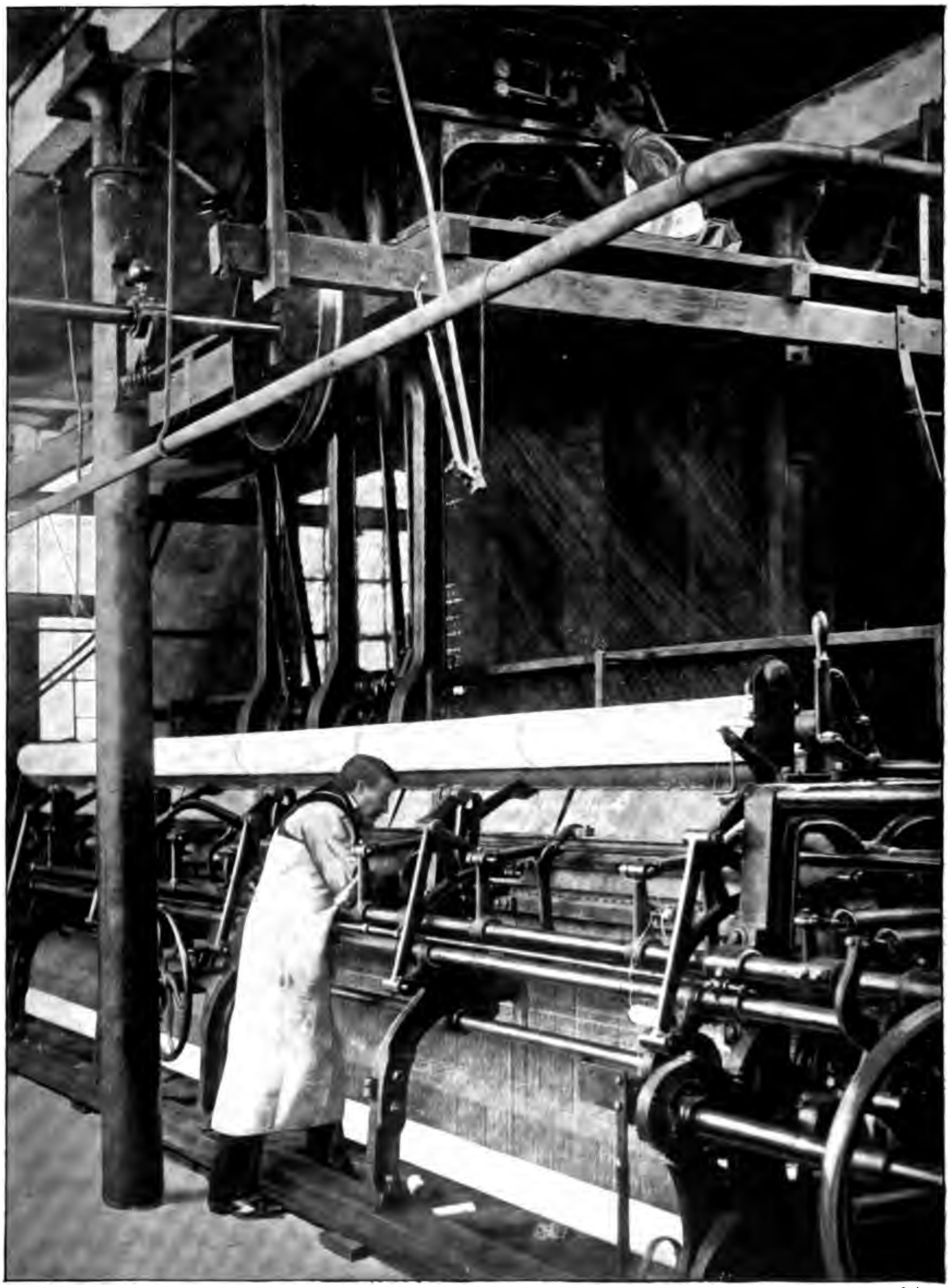
From these rural and thinly populated districts, the lovely shores of Lough Erne, the romantic combes of Devonshire, and the quaint hamlets of the home counties, we turn to the busy city of Nottingham, the birthplace and still the principal centre of machine-made lace. The process of manufacture is one of the most intricate and complicated among Britain's industries, and the machines used are standing witnesses to the ingenuity of man. According to Dr. Ure, one of the most competent of authorities, they probably surpass, in ingenious mechanism, those in use in any other industry. He declared a bobbin-net frame to be as much beyond the most curious chronometer as that is beyond a roasting-jack. Despite its complications, however, the lace machine is really only a development of Lee's stocking-

frame. The story is too long for telling here. It must suffice to say that at the beginning of last century Heathcoat invented a machine which made it possible to twist round each other an indefinite number of threads, and to cause each thread to traverse, mesh by mesh, every other thread in the width of the fabric being netted. The machine in general use, the Levers, is an improvement upon this, and new patents are continually being registered. To understand the process, however, we must visit one of the big Nottingham factories, by preference that of Messrs. Pratt, Hurst and Co., whose organisation admirably illustrates the different conditions under which the various processes are carried out. These are generally undertaken by distinct firms, but in the case of Messrs. Pratt, Hurst and Co. occupy separate factories, each under its own manager. Levers machines are established in one, curtain machines in another, bleaching and dressing take place in a third, and the final operations and the making-up are carried on in the warehouse in the district of Nottingham appropriately known as Lace Market. Another large firm has its curtain machines in Scotland, the lace being then brought to Nottingham for dressing and finishing, owing to the abundance of female labour in the lace city.

The first department to be visited is the designing-room. The designs are complete drawings, either entirely original or suggested by old fabrics, and the pattern is afterwards traced on drafting paper, ruled out into a network of very small squares, the course taken by the thread being carefully shown by the draughtsman. The squares are then numbered, and the numbers entered as a column of figures, this being handed over to an operator, who, with a special machine, having a keyboard something like a concertina, punches holes corresponding to the numbers in narrow strips of thin millboard, the arrangement of holes being groups of varying size. The cards, which thus contain the essence of the design, are then ready for transference to the Jacquard in the machine-room, whither we will follow them.

The rooms in which the machines are placed are well lighted and lofty, and the factories have to be built especially strong to sustain the tremendous weight on the floor. Levers machines are about nine feet high, and from 144 to 220 inches wide, Curtain machines having a greater width of from 170 to 360 inches. As many as 4,000 bobbins are often working in a machine at the same time, and in the manufacture of the finest lace twice that number are employed. It is impossible within the limits at our disposal to describe the complicated principles on which the machine works, but an idea may be conveyed by considering it in its simplest form as shown in the making of bobbin-net. The frame, or loom, holds vertically a series of warp-threads, with sufficient space between each to allow of a shilling being passed through edgeways. Behind the threads is a row of bobbins, which are, however, altogether unlike ordinary bobbins. They consist, in fact, of two thin discs of brass, rather larger in diameter than a penny and about as thick as a shilling, the thread being wound between them. The bobbins, fixed in what are known as "carriages," rest in an arrangement called a comb-bar or bolt-bar, and when the machine is set in motion each bobbin, carrying its thread with it, passes between two of the parallel and perpendicular threads of the warp, and is lodged in another similar bolt-bar in front of the warp. Then this bolt-bar "shogs," or moves, a space to the right or left, afterwards lodging the bobbin on another back bolt-bar one distance beyond its last space. So the process is continued through the length of the net, the bobbins, millions of which are in use in the big factories, being replaced when their thread is exhausted. The machines are worked solely by men boys assisting them by filling the bobbins with thread. They work in two shifts, and are paid by the piece, so much per "rack," the latter consisting of 240 meshes. Their hours are rather peculiar. The first shift comes on at four in the morning, and works until nine, when the second shift comes on until one. From one to six the first shift is again at work, and the second from six to twelve. Thus each works ten hours a day, and the machines are idle only four hours.

The above description of a lace machine applies only to the making of net, those for pattern lace being more intricate and having fitted to them the Jacquard apparatus, on



A LACE MACHINE.

Photo: Cassell & Co., Ltd.

which, as in fancy weaving, the cards act and give to the warp threads the varying movements required by the pattern. Standing in front of such a machine, one sees a long row of bobbins passing to and fro through the thousands of threads forming the warp with the regularity of a pendulum, the pattern appearing above after having mechanically undergone its wonderful transformation from mere thread. The machines are worked their whole length, lacing threads which are afterwards drawn out connecting the widths.

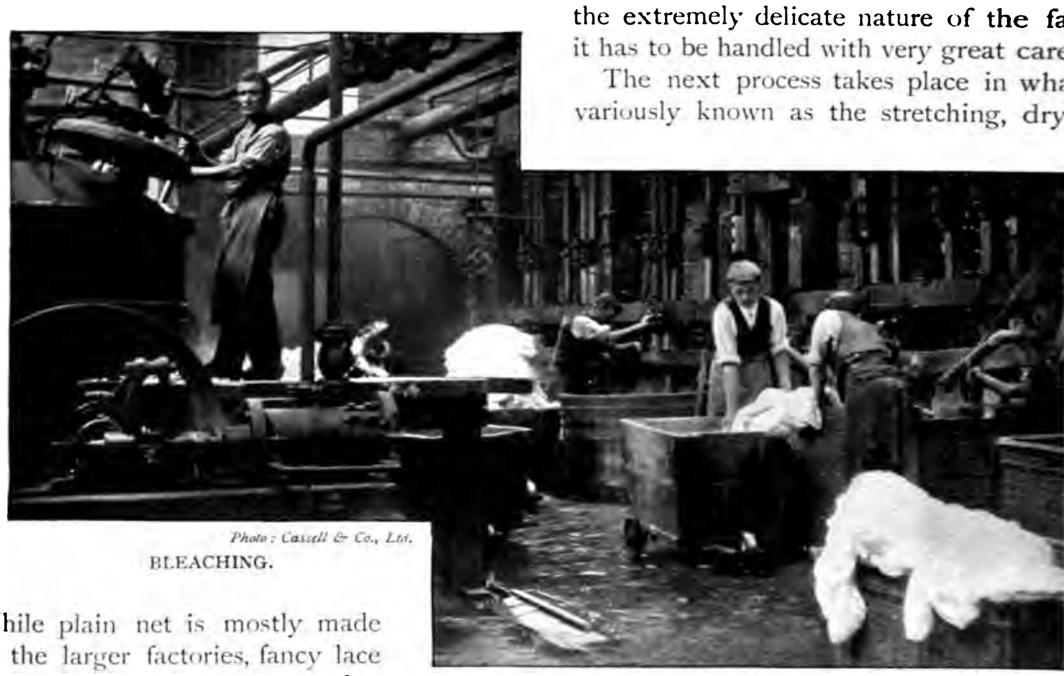


Photo: Cassell & Co., Ltd.

BLEACHING.

While plain net is mostly made in the larger factories, fancy lace is popular with those manufacturers who have only a small number of machines each. The Curtain machines are still more bewildering to watch, additional threads being used, and the Jacquard working from overhead instead of, as in the Levers, from the end of the machine. The large firms, too, have their own special mechanisms, the secrets of which they guard most jealously.

From the machines the fabric is handed over to the finishers, mostly women and girls, whose work is, as we have noted, generally carried on in separate establishments managed by different firms. The first process is that of bleaching, the feature of which is the interesting way in which the superfluous moisture is removed. The mechanism consists of a cylindrical vessel of wire gauze in which the lace is placed, the water being driven off by the rapidity with which the machine revolves. Hence it is taken in huge baskets to the "piece-room," where the required shade and colour is indicated by a ticket fastened to the bundle of the fabric. In the "dipping-room" it is placed in a mixture of gum, starch, size, and colouring materials, being afterwards squeezed between wooden rollers. Sometimes, however, the web is at once fastened on a frame and the "dress" put on the edge and spread over with brushes, this being done by a class of young workers known as "wetters." Owing to the extremely delicate nature of the fabric it has to be handled with very great care.

The next process takes place in what is variously known as the stretching, drying, or dressing room. It is of very great length, from 200 to 400 feet, and is occupied by two parallel horizontal frames, with an ingenious arrangement of fans overhead. The frames consist of two rails, between which the lace is pulled and fastened by girls, who are remarkably expert at the work. By means of a winch-handle they gently stretch out the web until all the meshes are open, delicately re-adjusting the rails from time to time, as, in the case of lace made from cotton thread, the net "swags," or stretches, in drying. Ladies' veils, eighty yards long and six or seven yards wide, beautifully designed curtains, and narrow lace for neck and underwear are here seen extending the whole length of the room, the threads which divide them up into the familiar patterns being just traceable.

DRESSING.

Photo: Cassell & Co., Ltd.

Another very interesting class of lace-workers are the "menders." Their duty is to examine minutely every part of the fabric and repair broken threads and other defects. The work naturally needs good light and keen eyesight. To aid them the girls wear black or blue aprons when dealing with white lace, and white aprons when mending the black fabric. They sit on low stools, and examine the lace by bringing it over their knees. There are also the "drawers," who draw out the threads which separate the patterns as they are made the width of the machine; the "clippers," who clip round the shaped edges of some kinds of lace; the "purlers," who put a fine edge upon it; and finally, those who roll the narrow lace on the cards and pack up the curtains ready for sale.

A very high degree of perfection has now been attained in the manufacture, and only experts can state with confidence whether any particular specimen is really hand-made Spanish lace, costly Barcelona, Brussels needlepoint, black Chantilly, or the remarkable imitative production of the newest type of machine. Foreign competition has, for some years, been very keen, the German factories turning out increasing quantities of cotton lace, and Calais and other French towns devoting themselves to the silk fabric. But Nottingham machines are still unexcelled, and they are best worked by native hands.

F. P. POINTON, B.A.

Photo: Cassell & Co., Ltd.

LACE "MENDERS" AT WORK.

[illegible] WORKS.

SOAP-MAKING.

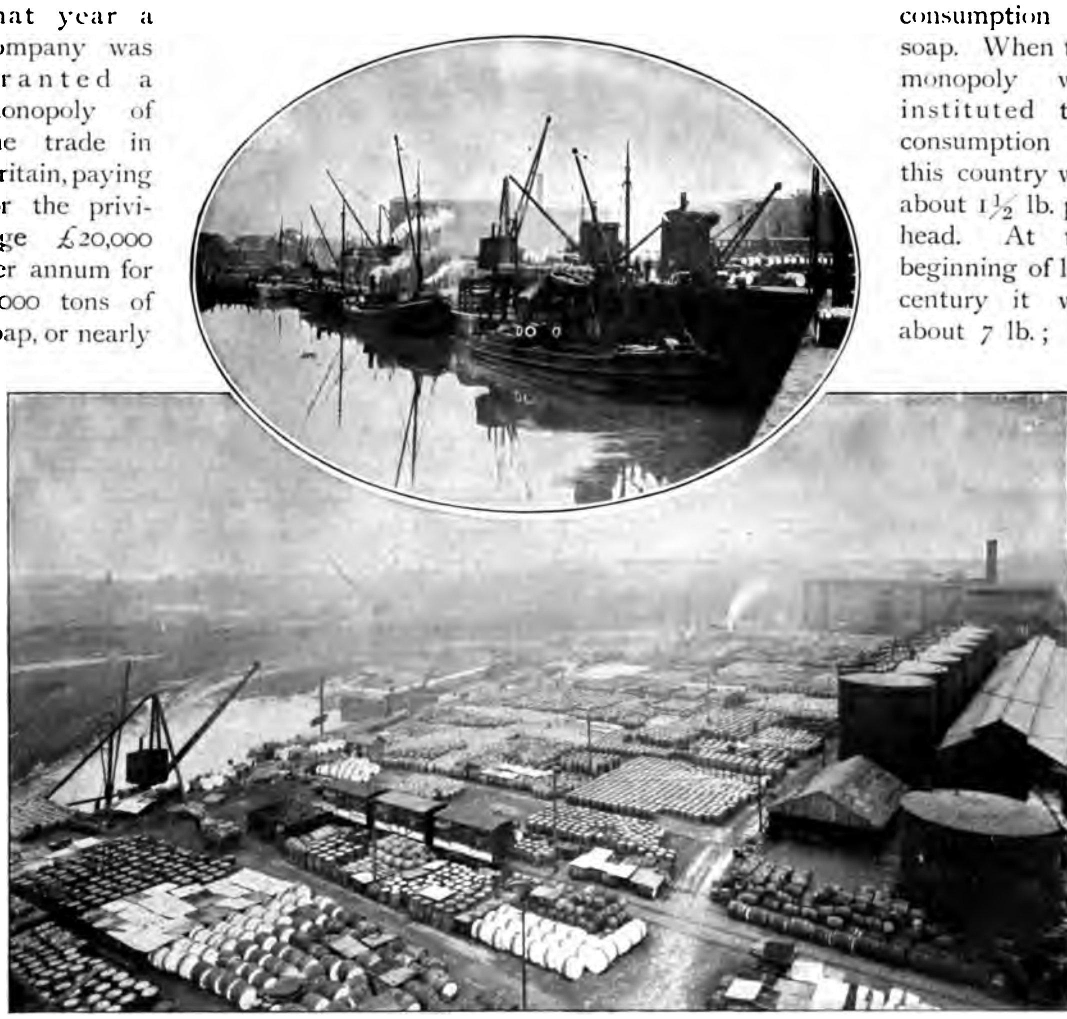
L[illegible]

[illegible] hardly be accused of [illegible] pride and arrogance when we claim that Britain has been notable for wealth and [illegible] and yet it [illegible] the country were by no means [illegible] the field [illegible] regard the common employment of soap. In view of the rarity of [illegible] it would, however, be rash to [illegible] that Britain maintained a scrupulous cleanliness before the introduction of soap. At any rate our forefathers were evidently as well washed as other civilised humanity. It is a national comfort to read, for example, the [illegible] words of an observant foreigner who travelled in Britain in the early days of the eighteenth century. "English men and [illegible]," he remarks, "are very clean. [illegible] passes by without their [illegible] hands, arms, faces, necks, and [illegible] water and that in winter as [illegible]."

The [illegible] of soap is heavily shrouded in the [illegible] of the past. Its origin is a fruitful [illegible] for speculation. It is mentioned [illegible] Testament, but what has there been translated "soap" is taken to mean [illegible]. The name is derived from the [illegible] word "sebum," and from that it has been supposed that it is to the Celtic people [illegible] the article itself. This view is somewhat strengthened by the fact that the earliest mention of soap is a reference by Pliny to its existence among the Gauls, who prepared it from goat's fat and the ashes of the beech tree. Among the ruins of Pompeii was found a soap factory, with a quantity of soap in a perfect state of preservation. According to one writer, the date of the introduction of soap into Britain was somewhere about the fourteenth century. Before that time it would appear as if fullers' earth was one of the principal detergents employed. Indeed, we find it was regarded as so valuable that it was made contraband and its exportation illegal.

Of the development of the manufacture and use of soap there is little known. As

early as the ninth century, Marseilles, which had the advantage of being situated in convenient proximity to the raw materials used in the manufacture, did an extensive trade. The first patent for the improvement of the manufacture of soap in this country seems to have been obtained in 1622. In that year a company was granted a monopoly of the trade in Britain, paying for the privilege £20,000 per annum for 3,000 tons of soap, or nearly $\frac{3}{4}$d. per lb. Trouble ensued. Some makers refused to join the "combine," and the King had to order that all soap must be examined by the company. In 1633 sixteen manufacturers were sentenced to heavy fines and imprisonment by the Star Chamber for disobeying the King's command, two of the poor men dying in prison. A few years later the monopoly was surrendered for the sum of £40,000. The soap-maker, however, had not yet reached the end of his troubles, for in 1711 a tax of a penny in the pound was levied on the commodity. In 1816 the duty on hard soap was as high as 3d. per lb. This was the summit of the imposition which was gradually reduced and abolished in 1853.



VIEWS OF THE WHARF, PORT SUNLIGHT.

The monopoly first, and then the tax, no doubt had the effect of keeping down the consumption of soap. When the monopoly was instituted the consumption in this country was about $1\frac{1}{2}$ lb. per head. At the beginning of last century it was about 7 lb.; by 1840 it had reached 11 lb., and at the present moment 20 lb. is believed to be a reasonable estimate. From this, it can be imagined to what dimensions the industry has grown in this country. Millions of pounds are invested in the business, and thousands of people are employed. For a long time, it must be mentioned, France has held the first place for toilet and scented soaps, but Britain has always held the palm for laundry soaps. During the past dozen years or so, however, this country

SOAP BOILING ROOM.

has made great headway in the toilet soap business, and so marked has been this advance that the premier position of France is seriously threatened.

Before proceeding to an inspection of a great soap factory, something must be said of the chemistry of the subject. Prior to the researches of the French scientists, Leblanc and Chevreul, the manufacture of soap was largely haphazard; it was certainly wasteful. To Leblanc's process for the manufacture of soda from common salt the soap-maker probably owes more than to any other thing. Chevreul's achievement was to analyse the constituents of fatty bodies and to discover the process for their separation. As a result, the industry was placed upon a scientific basis.

It would, of course, be out of place to enter into details regarding the technicalities of the subject. Besides, there are soaps innumerable, each differing in some particular from the other; thus the technical aspect becomes a very large one. Then, too, the soap-maker, who is not the least shrewd among men of commerce, is not disposed to reveal the secrets of his trade. But without indulging in the mysteries of chemical phraseology, some idea can be given as to what goes to make the soap we daily use. In thus limiting ourselves, we need have no fear of divulging trade secrets, for, after all, the ordinary constituents of soap are things of common knowledge. For hard soaps, tallow and the more solid vegetable fats are chiefly used, while for soft soap seed or fish oils are the principal ingredients. These fats, it may be necessary to explain, are mixtures of salts with glycerine as a base. Now by acting upon the fats either with soda or potash the glycerine is removed, and the remaining fatty acids unite with the soda or potash to form soap. For hard soap the agent employed to separate the glycerine from the fatty acids is soda, and for soft soap potash. Though really the chief cleansing constituents in soap, these alkalies, soda and potash, are by themselves very destructive. The fatty acids are thus the coating of the pill; or rather, it should be put, they neutralise the effect of the alkalies, which consequently carry out their cleansing mission without harm to the article under treatment.

Soap has been usefully defined as a sort of magazine of alkali which it gives up in the exact quantity required at any moment when it is rubbed with water. Bad soap is that which sets free the cleansing but injurious alkali too rapidly. A good soap frees the alkali slowly, and accomplishes its work in happy union with the fatty matter, which has a certain effect in preparing the way for the alkali. It comes about, therefore, that the object of the soap manufacturer must be to bring about such a blending of alkalies and fatty acids that in the completed article the dangerous elements, while sufficiently powerful for cleansing purposes, will be so far neutralised as to be innocuous.

Apart from the alkalies, the ingredients which go to the making of soap hail from the four quarters of the globe. Tallow, which is the most important of the fatty acids employed, comes from Russia, Australia, and the Americas—from the cattle-rearing countries, in fact. Then among the oils used are those derived from the palm, the palm kernel, cocoa-nut, the olive, ground nut,

linseed, cotton seed, etc.: the very mention of such names seems to bring us into contact with the most distant and some of the least inviting parts of the world. Resin is another ingredient which has the effect of rendering the soap more readily soluble, and helps to raise a pleasant lather.

The preparation of these various ingredients for the soap manufacturer are industries in themselves, though in some cases oil factories are run in connection with soap-making works. Generally, however, it may be said that the manufacturer buys his materials ready for mixing. They are carried in barrels, out of which the soap-maker melts the fat by means of jets of steam. The liquid is then run into tanks, where all impurities are carefully removed.

The next stage is the all-important one of boiling; and here we get in touch with the actual working. Enter, then, the boiling room. The atmosphere is hot and humid and fragrant, reminiscent somewhat of washing-day. The huge square pans, each capable of holding some sixty tons of material, are ranged in a double row. Some, you observe, are empty, save for a thickish remnant like a yellow scum that bubbles slowly and sullenly.

Standing by each of the full pans is a very warm and watchful attendant armed with a long spoon—a very long spoon indeed. With this from time to time he stirs the steaming mass, which bears a striking resemblance to butter-scotch, and at intervals he throws in a few shovelfuls of salt from a heap by his side. To the eye of the outside observer, there is not much that is illuminating in watching the boiling process. Only to the expert are the signs of gradual saponification easily apparent. Probably what strikes the outsider most is the curious demeanour of the soap at this stage. For a moment, perhaps, the mass of yellow matter steams quietly with scarce a tremor; then suddenly a crater opens in the centre of the pan and a violent eruption ensues, the splashes of lava, *alias* boiling soap, falling with an angry flop. Tending a pan is not, however, a dangerous occupation, though it calls for constant care and alertness.

The heat for boiling purposes is nowadays almost universally applied by steam injected directly into the pans through a coil of perforated pipes, one of the advantages of this method being that the steam keeps the contents of the pan continually in motion. There are in the boiling of ordinary hard soap actually three stages. After the first boiling, which completes the saponification of the fat, salt is thrown in to separate the glycerine and other impurities. Steam is then shut off, and the contents are allowed to settle. The impurities fall to the bottom, and are drained off. This done, a little water, resin, and more soda or potash are added. When the resin has been saponified, salt is again thrown in, again the contents are allowed to settle, and the impurities are drained off. Then follows another boiling with soda or potash, and the soap may be said to be made, the whole process having occupied about a week.

Still there is much to be done before the lady receives her stamped and highly finished tablet, or the washerwoman her humble bar. From the boiling pans, which are generally

SOAP COOLING ROOM.

STAMPING TOILET SOAP.

on an upper floor, run long wooden shoots, and down these the liquid soap is drawn off. At this stage some soaps are scented, some coloured, and some receive ingredients which result in cheapening them. But for most there is a direct road from the boiling pan to the cooling frame. These frames are about five feet high, and hold about fifteen hundredweight of soap. They are made of iron, the sides and ends being clamped together so that they can be removed, leaving a solid block of soap ready for cutting up. The cooling process naturally depends on the weather, but it generally occupies four or five days. While the soap is standing in the frames slight pressure is applied to it from the top to solidify it completely.

In a large factory, such as that of Messrs. Lever Brothers at Port Sunlight, the cooling room is an interesting and busy scene. When the frames have been removed from the solid soap, the workman sets about the cutting up of the great blocks. For this purpose he employs a machine consisting of an upright frame which is furnished with transverse wires, and these by means of a wheel and chain are drawn through the soap, cutting it up into slabs of the thickness desired. The slabs, creamy and beautiful, like new cheeses, are hurried along to another machine, where they are cut into bars. The mechanism which performs this operation is a lever frame on which are strung vertical wires that are drawn through the soap. The bars are afterwards piled in such a manner as to let the air circulate freely about them. A day or two of this exposure fits them for packing and for use.

Here we may take leave of the laundry soap, or rather of those soaps that are put on the market without the artistic finish we associate with the usual toilet soap. When the further processes applied to the superior kinds of soaps are to be gone through the bars are conveyed to another department. Here, first of all, the soap is thoroughly dried. This is done by passing the bars into a machine which cuts them up into ribbons, and carries these ribbons along through hot air till the moisture is removed. At this stage the soap feels to the hand not unlike wood shavings.

Scenting and colouring are the next opera-

DRYING SOAP IN BARS.

tions. In perfuming, essential oils are most commonly used in combinations, and the aim of the perfumer is so to blend the oils that the distinctive odours are retained and rendered effective without harming the *tout ensemble*. Among the oils most frequently employed are oil of lavender, spike oil, citronelle oil, oil of thyme, and oil of China cinnamon. In the matter of colours we are all acquainted in some degree with the variety which the soap-maker produces. Formerly the manufacturer was restricted to mineral pigments, which had a tendency to colour unequally and to fade on exposure to light. Coal-tar colours, however, which are now employed, have made it possible to produce the most varied, beautiful, and lasting tints.

When the soap falls from the drying machine, it is carried in quantities, according to the system in vogue in the factory, to the perfumer and colourist. He, as the result of careful experiments and tests, has his materials in readiness, and pours the necessary quantity among the creamy white soap. As one watches the operation, one is surprised at the small amount of perfume and colour that is required to permeate the mass. Of colour, for example, ten or twelve ounces suffice for ten hundredweight. Thoroughly to work in the perfume and colour, the soap is taken to the crushing mill, where by passing through a series of heavy rollers it is brought into a pasty condition. Again it is cut up into ribbons, and pours out of the mill like a tinted waterfall—a charming sight. This uniformly perfumed and coloured soap is forced through a tube to mould it into a continuous bar, which is cut into lengths for stamping as tablets.

PACKING SOAP.

Of the stamping of soap little need be said. It is accomplished either by steam or hand worked machines which are operated by boys or girls. The highly finished tablets of toilet soap are generally stamped by hand machines. Nor is it necessary to dilate on the wrapping of the soap, on which so much art is nowadays expended. Wrapping, packing, etc., are the minor operations of every firm dealing in household requisites of convenient size. The work has been on all hands brought to a high state of perfection, and the rapidity with which the girls and boys manipulate the various articles is amazing.

The lot of the worker in a soap factory is comparatively pleasant, though, of course, much depends on the character of the accommodation provided for him. In the larger factories, the conditions are excellent, and the worker has little to complain of. Then, all things considered, the work is not particularly trying. The soap-boiler requires to have an intimate acquaintance with the appearance of his material, so that he may observe the signs of gradual saponification; but, with the exception of the chemistry of soap and the colouring and perfuming, machinery is so largely used that the worker has a clean, healthy, and comparatively easy task.

JOHN MACLEAY.

THE MARKETS OF THE METROPOLIS.

LONDON is hardly a city of marts in the same degree as Paris, for in the French capital the markets are largely used for retail purposes, and the number of both buyers and sellers who frequent them is no doubt considerably greater, relatively to the population, than in the case of London. None the less do the markets of our capital hold a place in its life of which no mere words can convey an adequate sense. The exact number of "hands" for whom they find employment is not ascertainable, for as a nation we have no passion for statistics. But calculating from the known to the unknown, there can be little doubt, I think, that in one capacity or another—as members of the administrative staffs, porters, carriers, salesmen, slaughtermen, drovers, and so forth—fully twenty thousand men earn their daily bread as market workers.

Of all the markets of London, th interesting is Billingsgate, in the sha London Bridge. True, the Billingsgat fags who, to use Addison's euphemism so prone to "debates," have disap and the market is no longer the p was when an auctioneer ran the r being knocked down by a fair unless he knocked down the fish t The porters, in their dirty white s and with their well-lined hats, ar more pugnacious than their fellows in markets, nor is their vernacular in repute for raciness and vigour. Still, busiest hours, from five o'clock to nin market offers a scene which for anin and character can hardly be matched where in London. How it is that, everyone getting in everyone else's and acting on the assumption that market was made primarily for himsel

AT BILLINGSGATE MARKET.

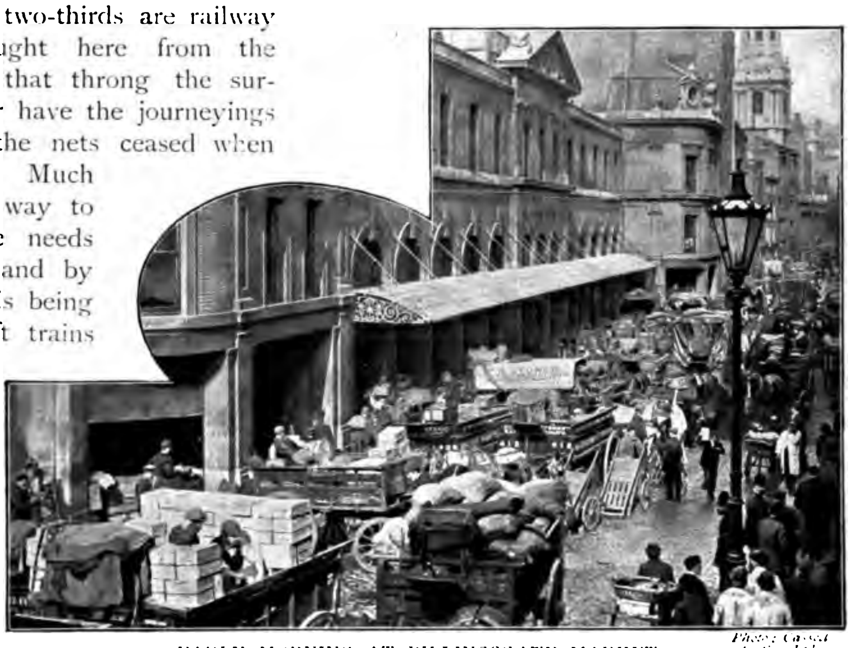
fish ever finds its way into the market and finds its way out again, is one of the puzzles of our social organisation.

The confusion, however, is a good deal less chaotic than the unsophisticated observer supposes. Else would it be impossible for 470 tons of fish to change hands here every day. Ten years ago 144,000 tons of fish passed through the market in twelve months; at the present time the quantity verges upon 150,000 tons. Of this, about one-third is brought from the fishing-fleets in the North Sea by the long, swift steamers that steal up the Thames during the night; the other two-thirds are railway borne, and are brought here from the termini in the vans that throng the surrounding streets. Nor have the journeyings of the produce of the nets ceased when it reaches the market. Much more of it finds its way to Billingsgate than the needs of London demand, and by mid-day the surplus is being whirled along by swift trains into the provinces to figure as the second course in the evening dinner in remote country places.

The burly porters, who are licensed for a nominal fee by the City Corporation, number close upon 900, and altogether some 1,200 persons find employment at Billingsgate. The porters are paid by the piece, and a steady, industrious man often makes as much as £3 a week. Their work, though hard, is not unhealthy, though it has a tendency to produce affections of the heart from the strain of the heavy loads which the men have to handle. Many of them, too, go bald at an early age as the result of carrying their burdens on their heads. From which it would appear that "head work" is no more good for the hair than is brain work!

Of the history of Billingsgate I may not speak. Suffice it to say that at least as far back as the reign of Queen Elizabeth it was a general market, and that for the last two centuries it has been used entirely for the sale of fish. The present market buildings, the work of the late Sir Horace Jones, were reared about a quarter of a century ago, when they superseded a much smaller structure.

To the same architect London owes the most commodious group of market buildings in this country. I speak, of course, of the Central Markets at Smithfield, which, with the additions that have been made to them for the sale of fish, vegetables, and other commodities, stretch right down to Faringdon Street. The market is, however, mainly for the sale of meat. A decade ago the meat, etc., sold here was about 300,000 tons in weight; now it is considerably over 400,000 tons. Perhaps a better idea of the volume of trade may be gathered from the fact that including the market-staff, about a hundred strong, between six and seven thousand men are employed here, of whom about a thousand are licensed porters and meat-carriers. At Smithfield business begins even earlier than at Billingsgate. The market gates are opened about the time when the votaries of fashion begin to think of going to bed. At four o'clock business has begun, and as



EARLY MORNING AT BILLINGSGATE MARKET.

Photo: Cassell & Co., Ltd.

Photo: Cassell & Co., Ltd.

THE FRIDAY MARKET: AN INTERESTING FEATURE OF THE METROPOLITAN CATTLE MARKET, ISLINGTON.

six approaches is in full swing and so remains until about eight.

Large as is the scale of transactions at the Central Markets, there is no overcrowding. How different is the scene, with all its activity, from that which was witnessed before Sir Horace Jones's building was raised, and when Smithfield was the home of the old Cattle Market! That until the middle of the nineteenth century the authorities should have allowed some two million animals to be driven through the streets of the City in the course of the year on their way to and from the Cattle Market says much for their conservatism and for the tolerance of the public. At last, however, though the City Fathers were in favour of letting things alone, the public would have no more of it, and in 1855 the Cattle Market was removed to Copenhagen Fields, Islington, where the Corporation had enclosed for the purpose an area some thirty acres in extent. As things have turned out, the accommodation here provided is in excess of the requirements, owing to the development of the foreign meat trade. Business at Islington is still, however, conducted on a considerable, though a gradually diminishing scale. Toll is annually paid on six hundred thousand animals, and, including the licensed drovers, some fifteen hundred "hands" find more or less regular employment here. A considerable proportion of the animals that change hands never leave the market alive. Thus in 1901 close upon 170,000 cattle, sheep, and pigs ended their careers in the slaughter-houses belonging to the market. That the Veterinary Inspector and his staff subject all cattle entering the market to severe scrutiny, to ensure that such as are unfit for food shall not find their way to our tables, may go without saying. In the course of the year some twelve hundred carcasses or parts of carcasses are condemned. Sure work is made of unsound animals, which are at once slaughtered and the carcasses destroyed.

The most interesting feature of the Metropolitan Cattle Market to those who are not bent on the driving of bargains over live stock is the scrap market, held on Fridays. No one who has ever seen the bewildering variety of things exposed in this market for second-hand articles would ever think of attempting to answer the question, "What can be bought here?" Rather would he say, "Ask me what can *not* be bought here."

It is curious to find from Mr. Charles Booth's monumental work on "Life and Labour of the People in London," which is a mine of information on the markets of London in their industrial aspect, that the drovers licensed by the City Corporation are for the most part not country-bred but Londoners. They begin, it seems, as ochre-boys—that is, they mark beasts for the butchers with ochre. On reaching years of discretion, having picked up a knowledge of the drovers' craft, they obtain from the Corporation, subject to the payment of a small fee and to proof of good character, a licence, and so become full-fledged drovers.

When it became necessary under the Contagious Diseases (Animals) Act, 1869, to provide accommodation for the slaughter of foreign animals brought into the Port of London, the City Corporation acquired the larger part of the old dockyard at Deptford, and spent nearly £150,000 in adapting it to its new uses, in addition to the £95,000 paid for the property. At present about a quarter of a million animals are landed at the jetties in the course of the year, but the number varies a good deal; and two years ago, before the importation of cattle from Argentina was prohibited owing to an outbreak of foot-and-mouth disease, it was close upon half-a-million. As all animals landed here have to be killed in the market within ten days of their arrival, it is not surprising that there are as many as seventy slaughter-houses, or that over a thousand men are employed in connection with the market. Covered lairage is provided for 8,000 bullocks and 20,000 sheep, and, including extensions, the refrigerating chambers allow of 4,000 sides of beef being chilled every twenty-four hours.

All the markets mentioned hitherto are the property of the City Corporation, and into the same category comes the Leadenhall Market, for poultry, game, etc., most

SMITHFIELD MEAT MARKET.

Photo: Cassell & Co., Ltd.

of it sold retail. The market really consists of a collection of shops, and it finds employment for over six hundred persons.

The most important of the fruit, vegetable, and flower markets of London, Covent Garden, is in private ownership, being the property of the Dukes of Bedford, to whom it was granted by charter in 1661. Architecturally its finest feature is what is still often called the Floral Hall, adjoining the Covent Garden Theatre, but for some years past this has been the home of the traffic in foreign fruit, and here are daily held auctions of fruits from foreign climes, such as pines, grapes, oranges, lemons, bananas, apples, and pears, "and so *ad infinitum*." In past years it was a customary thing to see at Covent Garden strings of carriages in which ladies from the West End drove to buy their flowers and fruit for the day; but in these days carriage folk prefer to make their purchases at the fruit and flower shops which have sprung up all over the town. But the wholesale business of Covent Garden has probably been steadily growing. Many hundreds of porters,

LEADENHALL MARKET.

Photo: Cassell & Co., Ltd.

licensed and unlicensed, are employed here, and it is roughly estimated that, not reckoning the costers or the flower-girls who come here in the morning for their day's supplies, the number of persons employed at Covent Garden does not fall short of five thousand.

The great fruit and vegetable emporium for the Surrey side is the Borough Market, of which the revenue is appropriated to public purposes. The Spitalfields Market (for fruit and vegetables) resembles Covent Garden in being in private ownership and in having been chartered in the days of Charles II. Mention must also be made of the Shadwell Fish Market, belonging to the London Riverside Fish Market Company, of the Hide and Skin Market at Bermondsey, and of the railway markets, such as the Great Northern Potato Market at York Road, King's Cross, and the Great Eastern Vegetable Market at Stratford. At the latter of these some seventy thousand tons of vegetables, etc., are disposed of during the year, and the handling of this produce finds work for some three hundred men.

W. W. HUTCHINGS.

COVENT GARDEN MARKET.

WITH THE RAILWAY SIGNALMEN.

IT is no exaggeration to state that the signalman, above all other members of the great army of railway workers, incurs the heaviest weight of responsibility. A little reflection and the fact becomes manifest; for the engineman, who is popularly described as having the lives of passengers in his keeping, is himself in the hands of the signalman, on whose correct manipulation of the levers and untiring vigilance he implicitly relies.

But the signalman is the railway official about whom the travelling public knows least. Whilst on duty he is cut off from the outside world, for the regulation that he must keep his cabin strictly private—a notice to which effect is always to be found on the door — is the most rigorously enforced of railway ordinances.

Many signalmen receive an early training in their duties — or, rather, first become acquainted with the nature of the latter—by acting as "train boys" in important signal boxes. "Train boys" are only utilised at busy centres, where traffic exigencies compel the signalmen to be furnished with juvenile aides-de-camp, to write up the train books, which record the times at which every train is accepted into the block section, signalled to pass, and cleared. Needless to say, this is the very best training for a youngster who wishes to become a signalman; for he soon learns to distinguish bell calls, and to understand the meaning and manipulation of the complex block telegraph instruments, repeaters, indicators, etc.

Signalmen, however, are not evolved right away from train boys. The former must be grown-up men, of at least twenty-three years of age; hence, when the latter have attained seventeen years of age, they relinquish their train-boy duties and become porters, lampmen, shunters, or perhaps humble members of the clerical staff. In course of time these and other aspirants, mainly drawn from the porter class, commence seriously studying to qualify as signalmen, without, however, relinquishing their present employment. The best place for this study is in some unimportant country signal box, where the traffic is light, and where in consequence the men in charge have time to impart practical instruction. Then, when a candidate thinks he has mastered the subject, he presents himself for examination by one of the company's signalling inspectors, who subjects him to a practical and written examination in the working of the double-line block system, and any other patent method of signalling—such as Tyers's Electric Train Tablet, the Electric Train Staff, Sykes's Lock and Block, or the Spagnoletti instruments—which may be adopted on his company's system. Most companies now also insist upon the would-be signalman qualifying as a telegraphist; at any rate, if he does not become skilled as such, none can hope to rise above the third-class rank.


Photo: Cassell & Co., Ltd.

TRAIN BOY BOOKING TRAINS, LONDON BRIDGE.

When a man passes his examination he is appointed a third-class signalman, which means that his duties are confined to wayside cabins where there is little traffic and shunting. The next step is second-class

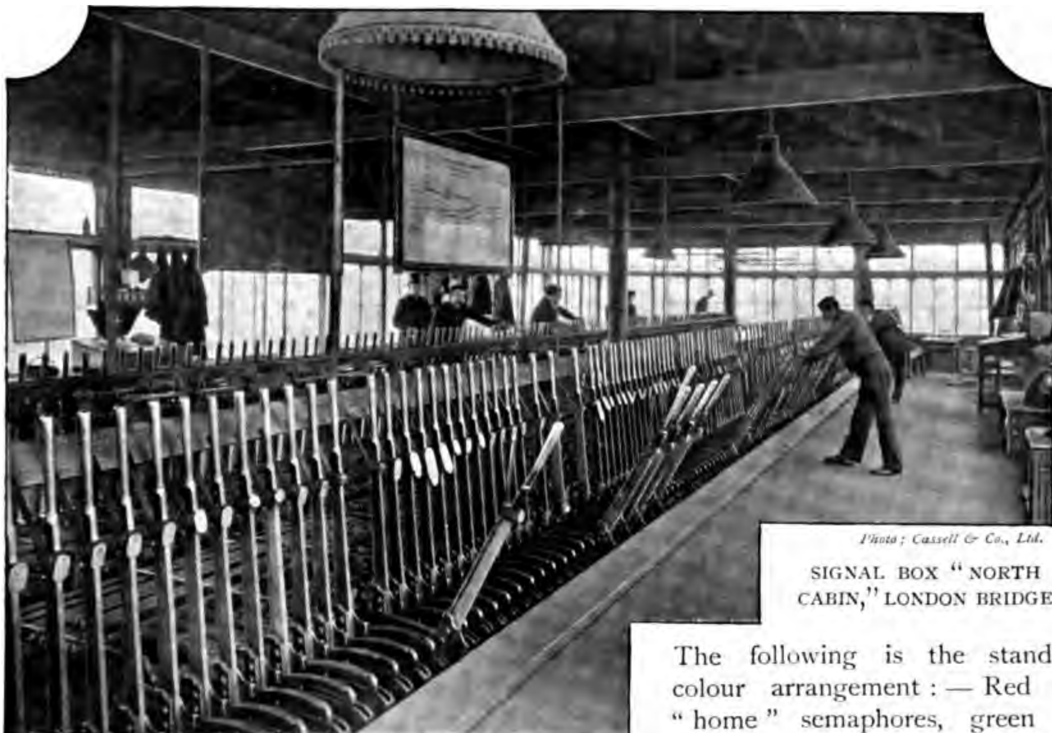


Photo: Cassell & Co., Ltd.

SIGNAL BOX "NORTH CABIN," LONDON BRIDGE.

signalman, that places him in charge of main-line and small junction boxes; and, finally, he is promoted to first-class signalman, which rank carries with it an appointment to the most important junction boxes in London and elsewhere.

In order to explain the signalman's duties, we must conduct the reader into the lofty, well-lighted, and commandingly situated edifice in which he practises his craft.

Entering the cabin, we find the lever frame placed parallel with the track, and immediately above it is a shelf on which stand the block, telegraph, and bell instruments; while above the shelf hangs a coloured chart showing the tracks, sidings, switches, and signals controlled by this particular cabin. The levers in the frame—the number, of course, varies with the size and importance of the cabin—have each a brass plate inscribed with a number corresponding to that which numerically signifies its position on the chart above; while on the far side of the frame is a board running parallel, on which is inscribed what each lever is—"Up home," "Down distant," "Slocum branch starting," "Main line cross-over," etc. It will be noticed that, with the exception of handle and spring catch, the levers are painted different colours.

The following is the standard colour arrangement:—Red for "home" semaphores, green for "distants," black for switches, white for spare levers, and fancy hoops for anything out of the ordinary. In junction boxes it will further be observed that many of the levers have numbers painted on their sides—not one number only, but in some cases from half a dozen to sixteen. These numbers refer to the interlocking apparatus. Before the numbered lever can be moved, each of the levers to which the numbers refer has first to be moved in the order scheduled.

Of the two bell instruments for the up and down tracks respectively, each possesses a different tone, or, rather, the up-line instrument sounds a bell, the down one a gong.

So many different patterns of block apparatus are in use that it would be impossible to describe them all in detail; though, of course, the special instruments by which each is represented have as their object the ocular definition of the empty or occupied condition of the block section, which is achieved either by needles, model semaphore arms, or suitably inscribed shutters.

The line is divided into sections, varying in length according to the amount of traffic that has to be passed over it—the thicker the traffic the shorter the blocks—and a signal cabin is placed at the termination of each section. Broadly speaking, the dial of a

block telegraph instrument indicates one or other of the following facts, viz.: "Line clear," "Train on line," "Line blocked." Sometimes it is a needle which does this; sometimes it is a miniature semaphore signal; and sometimes it is an arrangement of differently coloured and worded shutters, which revolve round an aperture in a green blind. The normal position of the block instrument shows the line blocked. Now let us suppose that A wishes to pass a train into the section A B. He notifies B of his wish; and B, having ascertained that the section B C is clear, signals back "Line clear." As the train enters the section A B, A signals to B, "Train on line." B repeats that signal to C as the train passes his own box, and at the same time signals back to A, "Line blocked," which A takes as a receipt, delivering him from all further responsibility for that particular train.

The communications between any two signalmen are always heralded by bell calls, for which there exists one uniform code, describing the nature of the train. Thus one beat calls attention; four, given consecutively, means "Is line clear for express passenger?"; five, given 1—4, "Is line clear for express goods?"; and two consecutively, "Train entering section." There are also arrangements of beats signifying "Obstruction! Danger!" "Vehicles running away on wrong (or right) line," "Stop and examine train," etc. With few exceptions, all bell signals must be acknowledged by exact repetition.

But signalling alone cannot ensure the safety of a train. The track itself, bristling with switches, cross-overs, and sidings, must first be prepared for it. This is provided for by intricate mechanisms, which interlock the signals and switches, and thus establish the principle of the signalman being compelled to set a road before he can unlock it. Consequently the most wonderful mechanical part of a junction signal box lies hidden from sight underneath the lever floor, and here the maze of plungers, rods, and cranks have the effect of creating a system incapable of producing discord.

Concerning the safety appliances that exist in the track itself for ensuring the correct working of switches, we have only space to mention the facing point lock and duplex detector, which bolts the tongues of steel in one position or the other; the locking bar—a long flat bar lying along the edge of the rail, close to a switch—which, each time the switch is moved, must be raised above rail

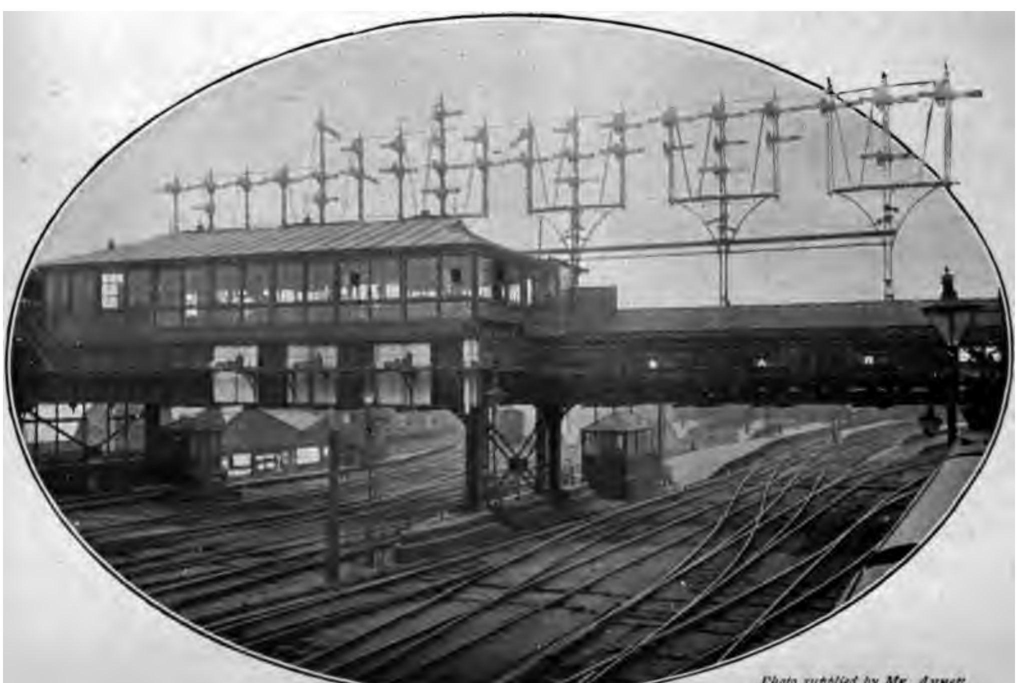


Photo supplied by Mr. Annett.

WATERLOO "A" SIGNAL BOX.

level, and therefore prevents a switch being moved whilst a train is passing over it; and another form of detector bar, which locks the ingress to tracks already occupied by a train.

We must now say a few words about those apparatus which make the trains provide for their own safety by automatically telegraphing their passage through a block section. The most famous of these systems is "Sykes's Electric Lock and Block," the object of which is to prevent more than one train being between two signal boxes on the same track at the same time. This is accomplished by a signalman not being able to lower the signal controlling the entrance to the block section ahead until that signal has been electrically released by the signalman at the box in advance, who cannot so release the signal until the preceding train has passed over a rail contact in advance of his own starting signal and that signal has been put to "danger." In the signal cabin two indicators are placed, one reading either "Line clear" or "Line blocked," and referring to the condition of the section ahead; the other reading "Train on line" or "Train passed," and referring to the section in rear. The former indicator is connected with the lock in such a manner that, when it reads "Clear," the lock is lifted and the lever is free; but when it reads "Blocked," the lever is locked. It is thus impossible for one signalman to organise a collision.

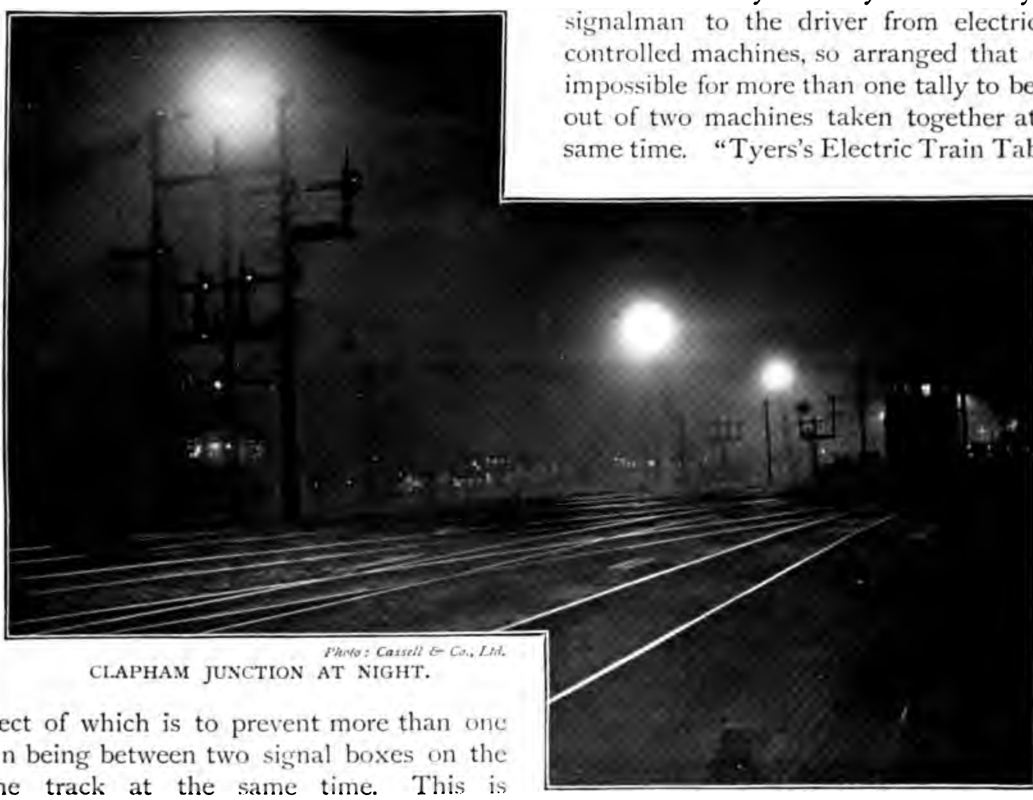


Photo: Cassell & Co., Ltd.

CLAPHAM JUNCTION AT NIGHT.

Coming to the working of single-track railways, there are several apparatus which prevent more than one train being between any two block stations at the same time, and, when no train is in the section, to admit of a train being started from either end. A staff or tablet must be carried with each train, and this form of tally can only be issued by the signalman to the driver from electrically controlled machines, so arranged that it is impossible for more than one tally to be got out of two machines taken together at the same time. "Tyers's Electric Train Tablet" and the "Electric Train Staff" are the two principal systems in vogue. In order to obviate the stoppage of a train whilst the driver and signalman exchange tallies, special apparatus are now provided so that the operation may be performed in speed. Sometimes the tablets are placed in leathern pouches and hung on rings, through which the two men respectively thrust their arms; a Scotch railway makes use of an apparatus, known as the "snapper," which exchanges tablets automatically on very much the same principle as the mail bags are caught up and set down in nets; and there are various forms of non-automatic "catchers" and "deliverers" placed alongside the track.

To return to the interior of signal cabins, there are, as a rule, many other dial instruments to be noticed in addition to the block telegraph ones. Where signals are hidden from view of the men in charge, an instrument, in the form of a miniature semaphore, placed above the lever to which it refers, repeats the working of the real arm; while another instrument is for use at night, when a lamp showing a red or green light respectively indicates the "on" and "off" position of the arm. The lamp repeater is a very ingenious apparatus. Over the flame of the lamp is a tongue of metal, which, as long as it remains hot, remains bent, owing to the unequal contraction of the metals composing it. If the lamp goes out, the tongue cools and straightens until it touches a button, which sets a bell ringing in the repeater, and changes a shutter inscribed "Light in" to one inscribed "Light out." Again, at the great boxes which guard important termini there are "train describers"—that is, dials inscribed with the names of the traffic dealt with, the nature of what is approaching being signified by the pointing of a needle—which obviate the use of multitudinous bell calls.

The walls of signal cabins are papered with official literature—these are the regulations for working the block instruments; a list of the platelayers (and their addresses) who are available for fog duty; a working time-table, showing the exact hour at which every kind of train is timed to pass the box in question; and a sheaf of the current month's notices, specifying the arrangements made for the special, excursion, and ballast trains, together with warnings as to what portions of the permanent way may be under repair. With the foregoing particulars the signalman is expected to be fully acquainted, and he is periodically examined in the same by travelling inspectors.

DRIVER AND SIGNALMAN EXCHANGING TALLIES.

The three largest signal boxes in the country are London Bridge (Brighton line) North Cabin, 280 levers; Waterloo A Box, 250 levers; and Liverpool Street West Box, 240 levers. The London Bridge and Waterloo boxes have each a staff of ten signalmen, who work in shifts, four in the daytime and two at night; while at Liverpool Street, during the busiest hours of the day, there are as many as five men on duty together. Each box has also a staff of train boys, who carry messages, attend to the telephones, and write up the train books. In the course of twelve months the number of lever movements made in these mammoth signal boxes attains several millions; for they deal with from 600 to 1,100 trains per twenty-four hours, not counting light engines, and there is an average of fully a score of lever movements to each train. And the pull of each lever is a heavy one, even to a strong man.

Lastly, a few lines about the great fog problem. In foggy weather all the foregoing arrangements are liable to be nullified by the driver's inability to see the signals; and, accordingly, some method of sound signalling has to be substituted. A primitive procedure, still widely utilised, consists of posting men at the side of the track close to the signal posts, where they can see the position of the arms. Whilst the latter are at danger, they keep a detonator or detonators on the metals, the explosion of

which warns the driver, and when the arms drop the detonators are removed. A fog detonator or torpedo is merely a little disc filled with detonating powder and provided with tin straps that are bent down to clasp over the top of the rail. This service, needless to say, involves considerable danger to the men, and great expense to the companies—the bill for a bad fog will run into many hundreds of pounds. In the neighbourhood of London and other large towns it is now usual for signals to have miniature replicas on the ground, so that the men can have the position of the arms on the tall posts above repeated under their noses; for, otherwise, in a really bad fog a "fogger" would be compelled to climb the post he is guarding to ascertain whether the signal is "on" or "off." Again, in order to obviate the risks of the men being run over whilst fixing the detonators, one company at least—namely, the Great Eastern—has constructed what are termed fog pits in the permanent way. These pits are long narrow trenches, about five feet deep, between a pair of running tracks, and the miniature repeaters are placed inside them. The foggers are posted in these pits, which are more or less sheltered, and are able to place the detonators on the metals without fear of being run over.

There can be no doubt, however, that the fog-signalling problem will never be really mastered until a mechanical device takes the place of human agency. As a matter of fact, patents innumerable have been filed with this object in view. Some of them substitute a mechanical for a human arm in placing a detonator on the rails. For example, there is a magazine detonator apparatus connected to a signal lever in such a way that, when the arm is at danger, one detonator is carried forward by a plunger, and placed in such a position that it will be exploded by the depression of a hammer near the rail, which hammer is released by the leading pair of locomotive wheels. If the detonator is exploded another one takes its place at the next movement of the signal lever. When the arm assumes the "clear" position, the detonator, if unexploded, is withdrawn to the magazine. An apparatus on this principle is installed on the South-Western Company's line at Clapham Junction, and works admirably.

But the weak point of any such system rests in the fact that the blow struck would be so tremendous that the pedals or triggers thus set would be liable to be easily thrown out of gear. Consequently, several electrical appliances have been devised to surmount this difficulty. For example, there is one the essence of which is the establishment at the side of the track, and along the outer rail, of a magnetic field. An armature attached to the locomotive is then carried through the magnetic field in the close neighbourhood of, but making no actual contact with, the magnets. In the armature there are two independent needles which, being deflected by the electric current, make a contact, and so ring a bell or perform some other operation to call the attention of the men on the footplate. Lastly, there is an electro-pneumatic automatic fog syren. When a signal is at danger, the train on entering the section automatically starts this syren blowing, and the latter continues its warning note till the train arrives at the signal post, with the arm of which it is connected, though, of course, if the signal meanwhile drops to the "clear" position the syren ceases to blow.

H. G. ARCHER.


Photo: Cassell & Co., Ltd.

SIGNALLING WITH FLAG.

Photo: Cassell & Co., Ltd.

FURNITURE DESIGNERS AT WORK AT MESSRS. WARING'S STUDIO.

THE FURNITURE TRADE.

TO the question, "How is modern furniture produced?" no single answer is possible; for the furniture trade is a trade of contrasts, and a description of the way in which one piece of furniture has been made might be wholly inaccurate as applied to another which, in appearance, is not very dissimilar. In the furniture trade eighteenth century methods of production and twentieth century methods co-exist in a manner that is almost unique. It is quite possible that your drawing-room may contain a chair or cabinet that has been the object of the careful, almost loving, attention for a considerable time of two or three highly skilled craftsmen, working with hand tools only in a small workshop, while your dining-room contains a sideboard that has been turned out in a few hours in a great steam factory in which the modern principle of the division of labour has been carried to the utmost possible limit, and the duties of the workmen have been chiefly confined to "feeding" the various machines—marvels of mechanical ingenuity—which have automatically performed nearly every part of the work, from the cutting up of the rough timber to the final decorative touches. Undoubtedly the present day tendency in this as in other trades is for machinery to displace hand labour, though it may be regarded as certain that hand work must always play an important part in an industry which has an artistic as well as a commercial and utilitarian side. To think otherwise would be to despair of the artistic progress of the nation.

There are few parts of the country where furniture making is not carried on to a greater or less extent, but, like so many other trades, it tends to concentrate in a few special localities. The London centre of the trade is Curtain Road, E.C., and the adjoining streets, which are largely given up to showrooms and factories, though the quantity of furniture actually made in the locality is less than it was some years ago, as many manufacturers have removed their works to various outlying districts. Of late years, too, quite a little colony of furniture makers has sprung up in Berners Street, W. In Tottenham Court Road there is an astonishing congregation of retail shops, a circumstance which makes the thoroughfare very attractive to engaged couples, but very little of the furniture shown is made here. Of provincial centres the most important and

interesting is High Wycombe, the famous chair-making town, which we have already dealt with in a separate article. At Glasgow and Beith, in Birmingham and the neighbourhood, and in the West of England (especially Bristol, Barnstaple, and Bath) the trade is also carried on very extensively.

A corollary to the widespread adoption of machinery is the subdivision of the trade into sections, so that one manufacturer, instead of making all kinds of furniture, will confine his energies to one or two special lines; thus one will make sideboards only, another mirrors and overmantels, another office furniture, and another "stuff over" work—that is to say, easy chairs and couches.

In order to examine the latest developments in the application of machinery to the furniture trade, we could not do better than pay a visit to the extensive factories at Limehouse occupied by the firm of H. Herrmann, Limited, a firm which confines its attention almost exclusively to sideboards and bedroom suites. Here about 650 men are employed, and the average daily output amounts to twenty sideboards and from ninety to a hundred complete suites. Such an enormous output is, of course, only possible by the utmost economy of labour and material which care and forethought, aided by the most perfect mechanical devices, can accomplish.

The factory backs upon the Regent's Canal, so that at the outset there is a great saving of cartage expense, the timber, most of which comes from the company's own saw mills in America, being brought to the works in barges. The wood has first to be thoroughly dried, and this is accomplished by what is known as the "progressive" drying system, which consists in passing the wood through successive chambers of varying degrees of moisture, the last being as dry as possible.

The dried and seasoned wood has next to be cut into sizes for use on various jobs, except in cases where this has already been done at the American saw mills. This sizing up is performed by a great number of power-driven saws of various kinds which, working with astonishing rapidity, cut the wood to any required length and thickness with the most perfect accuracy. The lengths of wood are then passed on to another set of workmen in another room, who shape and joint and decorate them ready for gluing together to form the completed piece of furniture. There are machines for planing, sand-papering, boring, moulding, dovetailing, grooving, mortising, even for such purely decorative processes as carving and inlaying. One

THE MACHINE ROOM, GREENOCK CABINET-MAKING CO.'S WORKS.

machine does nothing but cut in a drawer front the cavity which is to receive the lock; another takes the completed drawer and trims it to the exact size required to fit easily into the drawer space prepared for it—performing, in fact, just those nice adjustments on which the handicraftsman often spends a lot of time when the piece of furniture is virtually completed.

But most astonishing of all, perhaps, is the

Photo: Cassell & Co., Ltd.

WOOD-CARVING BY MACHINERY (MESSRS. HERRMANN'S WORKS).

use of machinery for purely decorative work. The wood-carving machine is a marvel of ingenuity, and produces work of the most elaborate as well as of the simplest kind. The process consists in reproducing in wood the pattern of an iron mould called a "negative"; a series of carefully adjusted cutters are attached to the negative, and when the machine is in motion they reproduce with the utmost exactness and precision every line of the original. Each machine is capable of carving simultaneously a dozen panels, not necessarily of the same pattern, and a single machine will in the course of a day turn out 120 completed panels.

At every turn one notices some evidence of forethought and ingenuity resulting in an economy of time or material, small, perhaps, in itself, but forming part of a system carefully devised to produce the maximum output at the minimum cost. The shavings and sawdust, for instance, instead of being wasted, are by an ingenious arrangement removed from the place where they are a hindrance and inconvenience and devoted to a practical use. Over each machine is fixed a conduit through which the dust and shavings are sucked up by means of a strong air current into a chamber where an artificially produced "cyclone" conveys them to an outfall leading to the furnaces. The stokers thus have brought to them automatically a continuous supply of fuel amounting to eighty per cent. of the total quantity required. Were it not for some such arrangement, the workmen at the sawing machines would be smothered in sawdust, so that it serves a useful end apart altogether from the saving effected in the cost of fuel. Even in such an apparently trivial matter as the lubricating of the engines a mechanical invention is introduced, which effects an economy in oil by collecting it so that it can be used over and over again.

In the scientific arrangement of the work of the factory, the completeness and "up-to-dateness" of its whole equipment, and the apparent indifference to an immediate outlay in order to obtain the utmost possible efficiency, we see in operation those business principles which we are sometimes taught to regard as essentially American. As a matter of fact, the British furniture trade has been but little affected as yet by American competition, and the claim sometimes made that our cousins on the other side can send their ready-made furniture into this country at rates which compete successfully with our English manufacturers is disproved by the experience of many well-known firms. In regard to a few specialities, such as certain kinds of writing-desks, the Americans have undoubtedly taken the lead, but in general classes of furniture it may be confidently asserted that British manufacturers are fully holding their own.

There is another and entirely different phase of the furniture trade which, in a

Photo: Cassell & Co., Ltd.

UPHOLSTERERS AT WORK AT MR. C. V. SMITH'S FACTORY.

Photo: Cassell & Co., Ltd.

CABINET-MAKING—INLAYING (MR. J. S. HENRY'S WORKS).

general survey of the industry, must by no means be overlooked. This may be described as the artistic, as opposed to the scientific, school of production. Instead of having a few stock patterns and reproducing them by machinery again and again in enormous quantities, the artistic maker will employ one or—if his business be a large one—several clever designers continually producing fresh designs, and these will be carried out almost entirely by handwork by some of the most skilful handicraftsmen that good wages can procure.

Several of the retail tradesmen make a certain amount of this high-class artistic furniture, and there are a few wholesale firms who devote their entire attention to it. Of these latter we may take Mr. J. S. Henry, of Old Street, E.C., as a leading example. A visit to his workshops is an experience very different from a visit to a great steam factory, such as we have just described. A couple of rooms on the third floor in a side street in the neighbourhood of Curtain Road, where about a score of cabinet-makers and two or three polishers and inlayers are at work: this is one of several workshops in which—small and unimposing though they are—the most beautiful furniture is being turned out, furniture which is a credit to British workmanship, and is destined to adorn the houses of some of the most tasteful and artistic people in the land.

The methods adopted in Mr. Henry's workshops are in diametrical opposition to those of the steam factories. The plan is for one man, or possibly two, to carry out a job in its entirety, from the rough timber to the inlaying and polishing stage. These last processes, of course, are special trades, but as far as the constructional work is concerned, the same workman will do it all. He receives from the drawing office a set of full-sized working drawings, and a sketch showing the appearance of the piece when completed, and with these as guides he proceeds to cut his wood to the required sizes, shape the parts and put them together, working at the bench with hand tools. Only for cutting out the very roughest of the work and for making mouldings is machinery employed. Working on these lines, the workman has something of the artist's satisfaction in watching the gradual development under his hands of a worthy outcome of his skill and labour, and the piece when completed has the additional value which, in the eyes of connoisseurs, belongs to skilful and conscientious craftsmanship as well as to appropriate and beautiful design.

The workman whose experience has been confined to "feeding" a moulding or planing machine in a steam factory would find himself quite at sea if presented with a set of working drawings and asked to carry out the work in the manner adopted in Mr. Henry's workshops and others of the same kind. Although both classes of workmen are engaged in the same trade and nominally doing the same work, the conditions of their work and the qualifications required for it are widely different. It must not be forgotten that though furniture making is a great utilitarian industry, it is also an artistic craft; it is that fact which has prevented, and doubtless will continue to prevent, the artistic

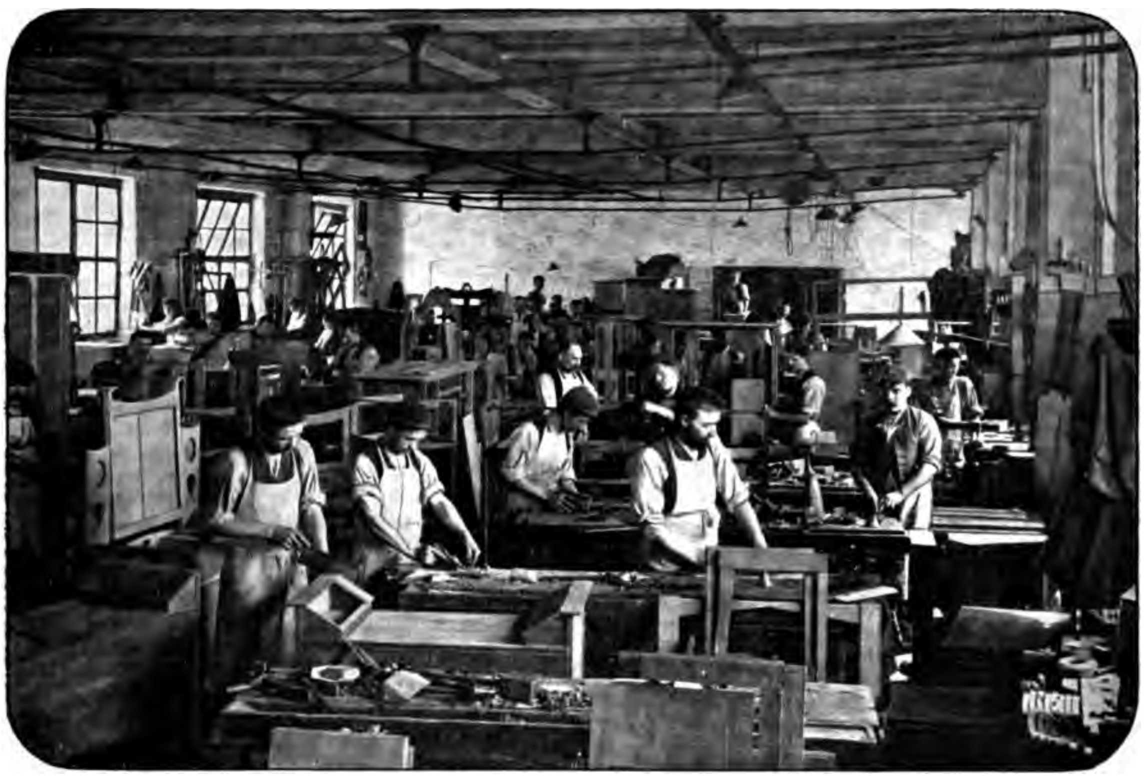
Photo: Cassell & Co., Ltd.

WOOD-CARVING BY HAND (MR. J. S. HENRY'S WORKS).

craftsman from being entirely superseded by the manipulator of labour-saving machinery.

The two firms which we have taken as types of two opposing schools of manufacture both confine their attention to the wood-working side of the trade. There are others, however, which include upholstery, a very important branch of furniture manufacture in these ease-loving days. Such a firm is that of Mr. Cornelius V. Smith, of Osnaburgh Street, N.W., of whose upholstering shop we give a photograph. It is a curious sight to see a lot of easy chairs and couches with their interior anatomy exposed to view, receiving the careful attention of skilful workmen which results in that luxurious softness and springiness everyone seeks—but does not always find—in an easy chair. Some of the secrets of those qualities we learn in the upholstering shop, where we see that the exceptional springiness of a divan settee we have noticed in the showroom is due to its possession of a double set of springs, and that the delicious softness of a specially luxurious chair is obtained by stuffing it with a mixture of horsehair and swansdown. Mr. C. V. Smith is the largest wholesale manufacturing upholsterer and cabinet-maker in the trade, and is one of the few firms in the furniture trade which manufacture practically everything that is required in the furnishing of a house from bedroom to billiard-room.

HUGH B. PHILPOTT.



A BUSY SCENE AT MESSRS. SHAPLAND AND PETTER'S WORKS, BARNSTAPLE.

THE MOULD LOFT, MESSRS. DOXFORD AND SON'S YARD, SUNDERLAND.

THE BUILDING OF SHIPS.

THE building of steel steamships is one of the most important of the industries in which Britons engage. A greater number of hands may be employed in the getting of coal or the spinning and weaving of cotton, and the gross value of the product in each of these trades may be annually greater; but viewed in the light of the fact that the manufacture of a ship really begins with the ores and the undressed logs, shipbuilding seems to be absolutely the greatest of our industries.

Just how many millions sterling are invested in shipbuilding and marine engineering plant it is difficult to say. The writer tried to form an estimate with the assistance of some well-known shipbuilders, and had to abandon the task as hopeless. In any case, the total would have been so vast as to be meaningless, and a better impression is conveyed by other easily accessible figures.

Great Britain, for instance, builds in a year about double the tonnage produced by the rest of the world. One British river—the Clyde—excels the output, including war-ships, of the United States, and almost equals the total production of both Germany and France. We continue to be the world's shipbuilders in the face even of subsidised opposition.

The value of the shipping launched in this country in a fairly prosperous year is, roughly, £27,000,000, and no less than £9,000,000 of that sum is expended in wages. Machinery is included in the estimate of the value, and engine-shop pay-rolls in the wages bill. The figures refer to the finished ship.

The number of men employed in shipyards and engine-shops is, off and on, about 130,000, and nearly a score of trades go to make the muster. A familiar division of them is into "black squad" and "white squad," but to the man in the street it is a little misleading. There are frame-benders, platers, riveters, caulkers, and drillers; shipwrights, joiners, and cabinet-makers; plumbers, blacksmiths, tinsmiths, brass- and copper-workers, and painters; pattern-makers, and steam, electrical, and hydraulic engineers. The rigger is almost extinct, but the army

of unskilled toilers seems to grow rather than diminish with the facilitation of labour.

It is safe to say that no British industry has kept in closer touch with progress than shipbuilding, and the commanding position it continues to enjoy is, no doubt, due to the enterprise which that indicates. And there never has been—can never be, in fact—any standing still in respect of equipment. The tendency is towards larger, if not faster, ships, and the expert smiles at the suggestion that the *Celtic* or the *Cedric* represents the limit. So far ahead of the times are the leading shipbuilding yards of the kingdom that half-a-dozen establishments can turn out leviathans which no British port could accommodate. If the ocean steamer stops at the *Oceanic*, the *Celtic*, and the *Cedric* the Port authorities will be the hinderers—not the shipbuilders.

Shipbuilding yards are to be found right round the British coast—from Aberdeen in the cold north, southward to the sunny Solent, and from Falmouth, north again to the Laggan and the Clyde. The great seats of the industry are, however, only two in number, and for the purpose of this article they may be described as the North-Eastern District and the North-Western District. The London river does not now build merchant vessels of any size, although the Thames Ironworks can, and does, construct the heaviest class of war-ships. The names of Yarrow and Thornycroft also suggest themselves in this

BOW FRAMING OF AN OCEAN LINER.

(From a photograph by T. & R. Annan & Son, Glasgow.)

MIDSHIP FRAMING OF AN OCEAN LINER.

(From a photograph by T. & R. Annan & Son, Glasgow.)

connection. Higher wages—due to the greater cost of living in the Metropolis—have, however, killed commercial shipbuilding on the Thames.

Taking gross tonnage as the measure, the North-Eastern District is much the more important of the two, but in point of value the output of the other division is probably better. War-ships are excluded from this comparison; if they were not, there would be no doubt as to which was pre-eminent. Most of the modern war-ship work is done on the Clyde, the Laggan, the Mersey,

and at Barrow, and these places are all in what I have called the North-Western District. The other division is made up of all the rivers which flow eastward to the sea—the Dee, the Tay, the Forth, the Tyne, the Wear, the Tees, the Hartlepools, and the Humber.

Beyond these districts there are practically no shipbuilding yards, though costly plant is employed on repairs all the year round, not

RIVETING FRAMES AND BEAMS WITH PNEUMATIC TOOLS.

(Photo supplied by Messrs. Gray & Co., Ltd., West Hartlepool.)

only on the Thames, but at Southampton and in the Bristol Channel as well. Repairs and overhauls are seldom unremunerative contracts.

Cargo steamers of ordinary type and size may be built on almost any of the rivers I have named, and practically every firm in the kingdom is a competitor for work up to a certain point. The range of possible contractors narrows as the size and the class of the work appreciate, until for the liner of, say, 10,000 tons gross only Clyde, Tyne, and Belfast concerns are interested.

Owners seldom go elsewhere than to the Clyde for sailing ships, although the Tay and the Forth have, in their day, turned out notable craft of the kind. The "wind ja mer" is, however, out of fashion, except wi oil companies and patriotic Frenchmen be on earning subsidies. To the Clyde, too, the orders for all the dredgers and dredgi plant the world needs. The ancient a royal burgh of Renfrew, which the "da sea-born city" soon may swallow up, enjo a monopoly of this work.

Tenders for cargo vessels up to abo 5,000 tons gross may, as I say, be soug almost anywhere in Britain. For the lin however, beyond that tonnage one h to go to Belfast or the Clyde. With fe exceptions, the ocean mail services of t world are carried on by vessels built in one other of these districts. The Atlantic line which fly the white star on the red groun were built at Belfast, the Cunard expre boats at Govan, the P. and O. mail steame at Greenock, the Royal Mail packets Govan and Clydebank, and the Union Castl fleet partly at Queen's Island and partly o the upper reach of the Clyde.

West Scottish firms have provided th bulk of the fast cross-channel steamers, an for many years the type has been a specialit with them. The fastest ships of this class— the Holyhead-Kingston boats—were, how ever, built at Birkenhead by Messrs. Lair Brothers, who also constructed the Weymouth Channel Islands fleet. All the other services except that *viâ* Harwich to the Continent are maintained by Clyde-built vessels, and the fastest and most luxuriously fitted of the paddle-steamers which ply from place to place around the British coast are similarly hall-marked.

Barrow, Birkenhead, Dumbarton, Clydebank, and Fairfield all build fast twin-screw Channel steamers, but only the three Clyde firms have done notable things with the paddle type. The Clyde, too, has usurped the place in the world of yachting formerly held by Southampton, and all the bigger boats of this kind are now built on its banks.

If one wants any type of ship, then, from the shallow-draught stern-wheeler for some tropical river to the speedy ocean liner, one turns first to the Clyde. If the quest be for a vessel to excel all else afloat in size and speed, the end of the journey is at Belfast. Or if a profitable cargo boat is the thing

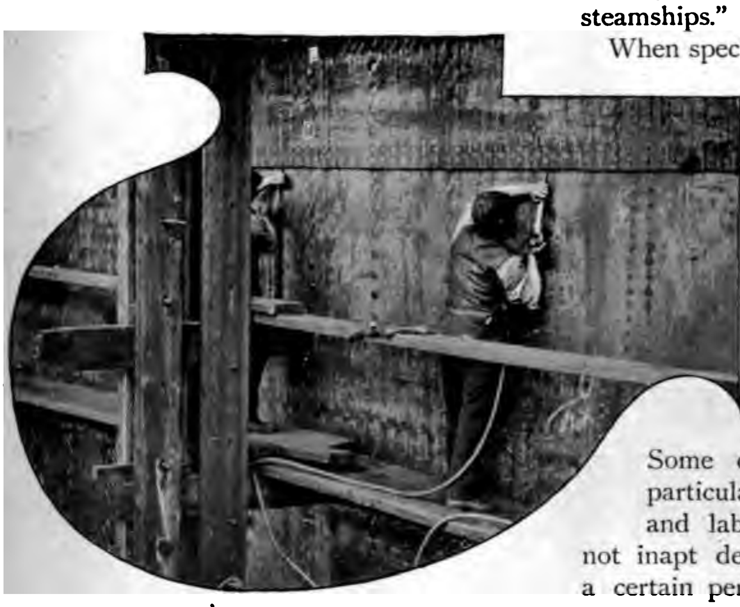
RIVETING CENTRE GIRDER OF A TURRET VESSEL.

PLATE ROLLS.

(From photographs supplied by Messrs. Doxford & Sons, Sunderland.)

desired—a ship to carry a great deal on very little tonnage and to make respectable headway with the least possible consumption of coal—one may go farther than the North-Eastern District and fare worse. The cheaper class of cargo boat is not unknown, of course, on the Clyde, but the East Coast has the art matured of building the type expeditiously and well.

To the untrained eye all shipyards are, no doubt, alike, and the operation of putting one boat together is very like the operation of building another. To a certain extent the impression is right, for experience is necessary to distinguish the variations of type. But if the casual observer fails to see beneath the surface of things it would have profited him more to spend the day elsewhere.



CAULKING SHIP'S SHELL WITH PNEUMATIC CAULKER.

(Photo supplied by Messrs. Gray & Co., Ltd., West Hartlepool.)

The whole vast establishment may seem to be in irretrievable confusion; and amidst the rattle of hammers, the roar of machinery, and the shouts of men no controlling force may be discernible. Over in the sheds frame squads and platers toil and sweat in the ruddy glow of furnaces; in the smithy brawny blacksmiths twist and hammer shapeless masses of incandescent metal; in the shops joiners work wood in an aimless sort of way, and engineers dream beside machine-tools which run for hours at a stretch; and down towards the river the "black squad" are riveting the keels, and shells, and decks of leviathans that are to be. No order seems to be anywhere; everything proceeds in a happy-go-lucky way.

Yet there is absolute order from boundary wall to boundary wall, from gatehouse to water's edge; and every man of the 7,000 on the pay-roll is working as closely to a general plan as if his duty had been defined and typewritten for him in the grey of the early morn. Shipbuilding would be unremunerative otherwise, and Britain would not be "the country of cheapest production of ocean steamships."

When specifications are issued for a steamer of any size, every firm which fills them in sees the whole process of construction clearly before it despatches its tender. All the steel and other materials that will be needed are ordered provisionally at a quoted price, so that if a tender is successful there will be no rising market to eat into the estimated profit. Some concerns—Harland and Wolff particularly—merely charge material and labour—"time and lime" is the not inapt description of this system—plus a certain percentage as profit, but the rule is, as I have stated, to quote a price including profit.

A brief spell of abnormal activity in the drawing office succeeds the formal acceptance of a tender, and then the whole operation of building the ship begins—not tentatively, be it noted, or half-heartedly, but definitely, and all, as it were, at once. Working drawings are got out, and the "lines" of the projected vessel are laid down in full on the great floor of the moulding loft, to be transferred in part at a later stage to the scrieve board in the frame shed.

If the practice were to build one ship at a time or six ships simultaneously, there would of necessity be a certain order of employment, and the strain would be on one department after another. You rarely find, however, even two ships at the same stage of construction. In most yards there will likely be vessels on the stocks at various stages—the

DRILLING BEAM KNEES WITH ELECTRIC TOOLS.

(Photo supplied by Messrs. Gray & Co., Ltd., West Hartlepool.)

keel of one just laid on the blocks, the gaunt skeleton of another beginning to show, a third partly plated, and a fourth in all the glory of its first covering of paint.

But our concern had better be with one vessel only, because in the contemplation of half-a-dozen there is almost sure to be confusion. For this particular vessel truck-loads of plates and angles and beams arrive daily by rail, and are sorted out or stacked on end in the yard. The shipwrights have laid their keel-blocks by this time, and along the narrow-gauge railways, which skirt the building berths, come the "black squad" in their wake with keel-plates and so forth.

The shops begin to waken up in the interest of the firm's newest client, and by-and-by every detail of the vessel is in the hands of the right people. Brass-workers, plumbers, and other minor tradesmen are at the fashioning of fittings, and joiners at the woodwork for saloons and cabins and deck-houses. The boiler-sheds reverberate with the roar of the riveting hammers, and the engine-shops are all a-bustle with the press of work there is to do.

And if time is precious and machinery is needed in a hurry, the roar of the engines and the clatter of the hammers last through the long night, squad succeeding squad when the sun sets and the day breaks.

The frame squads reproduce the lines, which the scrieve board shows, on the perforated iron floor around the furnaces, and then twist the incandescent angles into the desired curves. When the great ribs of steel cool they are taken on trucks to the building berths and handed over to the shipwrights, who place them in position and "fair" them to the keel. Beams and other contributions to the rigidity of the structure follow, and the way is clear for the plater.

The platers until now have been preparing their work for fitting, using powerful hydraulic tools, which roll and punch and shear the cold steel as if it were cheese. Every plate has its appointed place in the shell, and has to be as carefully adjusted as part of a

BENDING FRAMES FOR TURRET VESSEL.

(Photo supplied by Messrs. Doxford & Sons, Sunderland.)

machine. If it is not absolutely according to the drawing it will not rivet. When it is fitted and screwed upon the frames the riveters come along and rivet plate to plate and frame, and after the riveter follows the tester, who "chalks" every rivet which is not perfectly driven; these have to come out. Then the iron caulkers hammer the edges of the plates; and by-and-by the hull is watertight. Tanks, castings, and steel decks are treated similarly, and the joiners go aboard with the fittings that have accumulated in the flats.

When a liner of any size reaches this stage of her construction, the number of men at work on her may be anywhere between 1,000 and 1,500. There is, of course, a limit to the staff which may be employed profitably on a single ship, but I have seen considerably over 1,000 at work on the *Celtic* without the slightest sign of overlapping.

Photo: Lafayette.
A GREAT LINER NEARLY READY FOR LAUNCHING AT BELFAST.

A great deal of the staging and some of the uprights are removed when the ship is wholly plated, and a little army of painters is set to work on the hull. The shipwrights effect further clearances below the bilges, and put down what are called "standing ways." Over these—with a liberal coating of tallow between, of course—are laid "sliding ways," and stout cradles are built under the ship forward and aft.

Some time before the launch the wedges below the bilges are displaced, and the vessel, through the cradles, rests practically on the sliding ways. The means used to keep the sliding ways in these circumstances from acting up to their description vary in different districts. At Messrs. Harland and Wolff's the practice is to hold the sliding ways by a hydraulic apparatus, from which the pressure is withdrawn when "All clear" is signalled. The ordinary method is, however, to let lengths of wood called "daggers" into niches in both standing and sliding ways, and to force them out by blows from heavy weights. That is what happens when the lady who names the ship cuts the mystic cord or ribbon—she releases the weights.

Vessels are rarely in a hurry to leave the ways, and the first minute of their freedom represents a rather distressing time for their builders. Nearly all ways have a camber in them, to make progress along them easy, and a jack is used under the forefoot of a vessel to throw the weight gradually over it. The woodwork of the cradles creaks ominously as the pressure is applied, and then loud cheers greet the first movement of the huge mass of steel. It gathers way as it proceeds towards the water, and when the tide bears it all it is "checked"—brought slowly to a standstill, that is—by means of chains whose shore ends are anchored in the yard.

Tug-boats, which have stood by all day, tow the new vessel to her fitting-out wharf,

LAUNCHING A TURRET VESSEL.

(Photo supplied by Messrs. Doxford & Sons, Sunderland.)

and the work of completing her proceeds apace. Engines and boilers are put aboard; masts are stepped, and funnels put in position and stayed. There is still employment on her for hundreds of men; and decks and alleyways and saloons are to a greater extent than ever littered with gear. But gradually everything visible becomes shipshape. The boats are swung on the davits, and the lighter superstructures finished off. Painters swarm along the decks, making everything glisten in the sunlight; upholsterers and polishers throng the saloons and cabins; decorators adorn this, that, and the other thing; and electricians busy themselves with clusters and lamps and annunciators.

The number of workpeople grows less and less, until the day comes for the first of the steam trials in the open sea. The crew are on board now, and the officers are busy fitting keys with locks and locks with keys, and generally assuring themselves that the contract has been carried out to the letter. After speed trials, and consumption trials, and steering trials comes the formal cruise; then the house flag is broken out at the main and the Blue Peter at the fore, and another shuttle in the Empire's loom begins its work.

ROBERT MACINTYRE.

TURRET VESSEL ON TRIAL TRIP.

(Photo supplied by Messrs. Doxford & Sons, Sunderland.)

SWEETMEAT MAKING.

SWEETMEAT making is an industry which employs a far greater number of women and girls than men and boys, since with the exception of the management of the actual machinery and the cooking, the work is all light, merely demanding deft handling; and its conditions are such that workers of ages varying from that of the just emancipated Board School girl to her grandmother are equally welcome. It is a healthy occupation, and as the record of service is, as a rule, long, one is justified in concluding that the perpetual smell of hot sugar, chocolate, fruit-extracts, and peppermint is not injurious; also that the constant eating of such dainties as fondants, burnt almonds, and the many varieties of "lozenge" is not detrimental to the health of the workers.

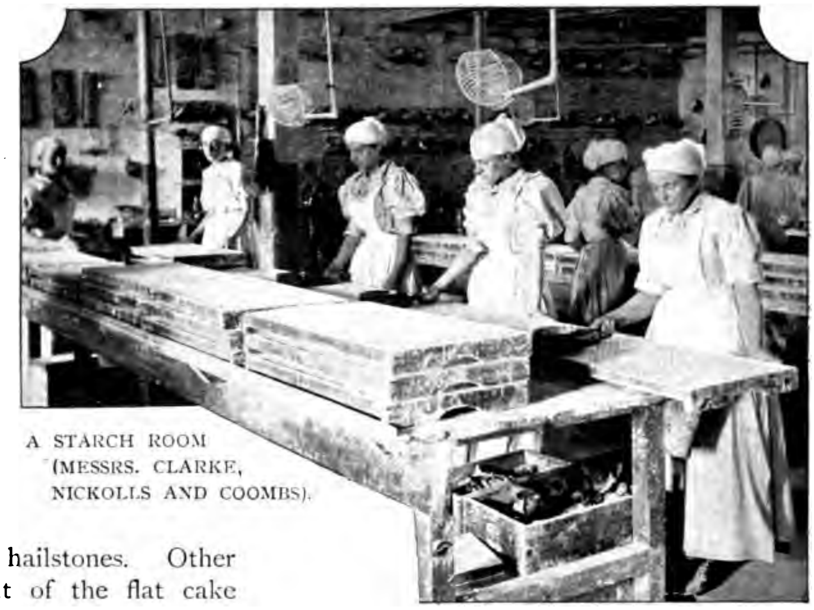
SUGAR-WAFER MAKING (MESSRS. CLARKE, NICKOLLS AND COOMBS).

That the fascination of sweet-eating is much more a matter of temperament than only dependent on the opportunity to succumb to it, is proved by the number of years which it holds some of these factory hands enthralled. In many cases they keep up an unending chumping, no sooner having got rid of one item than they start on the next—like constant smokers with their successive cigarettes. A wise manager does not forbid such toll being taken, for that so demonstrative an appetite will insist on being satisfied, with or without leave, is too patent a fact to need reflection. He is therefore only prohibitive in the matter of wholesale tax-levying for the benefit of the home circle.

In dealing with such a varied manufacture as that described as "Sweets," one's chief difficulty is in selection. Where to begin, when each department is so full of attraction; when acid drops, almond hard-bake, nougat, "bull's-eyes," liquorice, barley sugar, comfits, and lozenges all demand attention. To remark comprehensively that the beginning of everything in this connection is *boiled sugar* may perhaps provide a satisfactory starting point—although maybe of too obvious a nature to excuse its intrusion. Let us visit a large sweet factory, that of Messrs. Clarke, Nickolls and Coombs, and see for ourselves how these ever-popular articles are manufactured in their countless millions.

Huge coppers line many of the rooms of the factory, whilst all the centre space is taken by long metal-topped tables, whereon the manipulation of the hot sugar takes place. All the family of transparent "drops"—acid, fruit, etc.—are made in the same way, the difference being merely a matter of flavouring. Sugar that has been boiled at a temperature of 320° is allowed to run from beneath an elevated copper on to a table, where after getting a little cool it is worked by hand into great flat cakes and kneaded, just like dough for bread; then, when the final state of it is to be acid drops, a small quantity of

extract of lemon is worked in. More kneading follows, and then when cool enough to have stiffened into almost a solid mass, it is pulled into long narrow bars and squeezed between metal rollers, the surface of which is stamped with little round holes; the rollers are given a turn, the dough-like sugar mass fills every hole; another turn, and out fall the "drops," like a shower of very large hailstones. Other varieties are stamped out of the flat cake of material by metal sheets covered with divisions. After this treatment the fruit drops remain slightly attached to each other, and require to be divided by hand, an easy work undertaken by quite young girls, who are also kept busy filling glass bottles with these sweets, by means of large-mouthed funnels.



A STARCH ROOM (MESSRS. CLARKE, NICKOLLS AND COOMBS).

In the nougat department we see machines "whisking" the scores of whites of eggs that go to its concoction, and standing beside them we notice the immense barrels of honey —honey from California—which, with pistachio nuts, completes this delicious compound. The ingredients having been amalgamated, the nougat is laid in wire shelves to harden, and after a few days' waiting it is submitted in long bars to a machine, which cuts it with incredible speed into the convenient little blocks in which it reaches the public.

In striking contrast to the inviting whiteness of the nougat is the aspect of tubs full of liquorice, which is capable of being manipulated by deft hands into a great number of forms, such as long thin "bootlaces," short thick cubes, sticks, drops, and "worms." A particularly ingenious machine —not unlike that popularly known as a "mincer"—is employed for the manufacture of the last variety. Having been filled with warm liquorice, the machine produces out of twelve small apertures twelve "worms" a quarter of a mile long! Needless to say, their rash career is harshly checked by attendant work-girls before they have had time to grow to anything like this embarrassing length.

Another division of sweet-making capable of infinite variety is the "lozenge," ranging as it does from the delicately scented cachou, through many grades of elegance, down to the rampant peppermint; but whatever its flavour, every lozenge is made in the same way—a sweet, pudding-like mass is taken from the slab where it has been alternately thumped and flattened, and is thrown on to an arrangement called a "traveller," which passes under a machine fitted with a set of punches. These, at each stroke, punch out a row of lozenges at the rate of some 1,500,000 (one and a half millions) a day, the surplus material between the holes being automatically carried off to be worked up again.

Such things as jujubes, and the vast number of models of the order of the well-known "bananas" and so on, are classed professionally under the term "gum work," and demand specially careful manipulation. They are made in moulds, each separately, in the following manner: A tray is filled with starch-flour, the smooth surface of which is indented with rows of little hollows of the desired shape; a cylinder filled with liquid sugar-stuff is allowed to drip into each little mould, and the tray, when covered with tiny

THE FRENCH CREAM ROOM (MESSRS. CLARKE, NICKOLLS AND COOMBS).

THE LIQUORICE ROOM (MESSRS. CLARKE, NICKOLLS AND COOMBS)

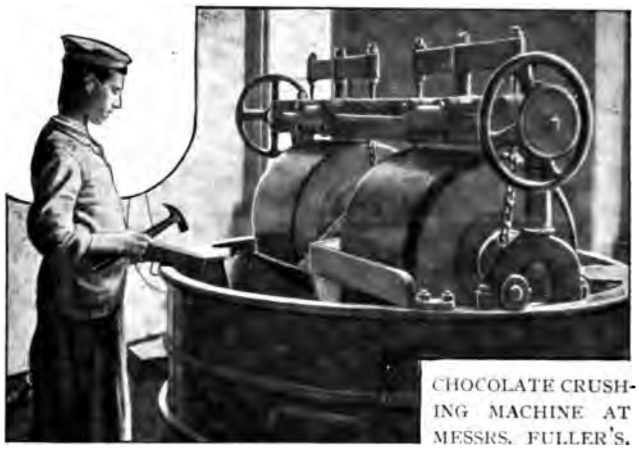
wells, is set aside to cool, or is put on a shelf with many hundred others in a hot-air chamber, according to treatment required.

Cream sweets, fondants and the like, also result from moulds, but in their case india-rubber moulds are necessary. The cream, which is simply boiled sugar beaten into a thick mass by a sort of gigantic copper churn, flavoured, and tinted (with vegetable colour), is deposited by machinery into rows of little wells many at a time. A short while to cool, then the indiarubber trays are turned upside-down, and out jump the finished fondants. Sugar wafers have a little department to themselves, and a special set of implements is necessary for their evolving.

Cocoanuts figure largely in the manufacture of sweets. They arrive at the factory in a ceaseless stream, never having time to do more than lie a day or so before they are seized upon and converted into some form of sweet. Armed with a hammer, a man knocks off the shell and throws the nuts into an enormous bin; out of that two women pick them and hold them against a set of blades worked by machinery, which deprive them of the hard brown rind. Then the white balls are dropped, several at a time, into cauldrons containing paddles working rapidly in opposite directions, so that if a nut escapes being smashed by one blade it is caught by another, and before it emerges becomes reduced to very small pieces; a secondary process further "pulps" it, and the final touch is given by a grinder. Then the cocoanut is ready to be mixed with sugar and converted into "ice," rock, and all the other forms of sweetmeats of which it is the foundation.

Sugared almonds and caraway comfits look to the inexperienced eye simple, unpretentious sort of confections; but it takes an almond four days' and a caraway seed six weeks' incessant rolling in boiling sugar, poured on in very small quantities, to reach completion.

The seed, or the almond, serves as the starting point, it being necessary that the sugar should hold to something. Having been given their preliminary dose of sugar, the caraway seeds or the almonds, as the case may be, are put into huge copper pans tilted at an acute angle; these pans are kept revolving, so that the sweets they contain are perpetually rolled in every direction. The noise made by thousands of almonds and twice as many comfits all rolling round the sides of the copper pans, and, when the incline gets too steep, suddenly falling, is enough to make speech in this neighbourhood futile. The effect of this mode of treatment in making almond sweets and their smaller varieties is, by constant friction one against the other and round the pan, they should acquire the desired symmetry and equal size. This is a division of confectionery that needs specially careful watching, and is unusually slow of completion.



CHOCOLATE CRUSHING MACHINE AT MESSRS. FULLER'S.

A speciality in the way of sweet preparation is carried on by Messrs Mackenzie and Co., of Dalston. It lies in the fact that nothing is issued *loose*; every item is wrapped in thin paper; packets within packets, every division in its own paper. The advantages of this arrangement will be readily apparent, the sweets thus reaching the consumer uncontaminated by exposure. Butter-scotch, toffee, peppermints, almond cream, "Fendean," all share the same cleanly fate. Here we may see the manufacture of a popular variety of toffee known as "Soutouma." The ingredients, brown sugar and butter, are first of all weighed into white enamelled dishes in a cool recess of the boiling-room, and white-garbed cooks preside at neat stoves. The boiled mixture is poured on to slabs kept cool by pipes of cold water passing

beneath them, cut into the desired sizes, and then left for a small army of girls to come and envelope piece by piece. Messrs. Mackenzie were responsible for the introduction into this country of the milk-chocolate made by Peter, of Swiss renown.

COVERING SWEETS WITH CHOCOLATE AT MESSRS. FULLER'S.

Our account of the manufacture of sweets would not be complete without a brief reference to the making of chocolate bon-bons and similar dainties for which Messrs. Fuller are responsible. The cream middle part is made first, in the same way as fondants, but the critical part of the process comes with the covering, each little lump of "cream" having to be dipped by hand—that is to say, lying on a two-pronged fork held in the hand—into a bath of liquid chocolate: so it is a slow process, especially as unless the chocolate be kept at just the right temperature it refuses to set, or, having set, to attain the correct amount of gloss on its surface. Then, having gained its overcoat, each cream must be laid carefully down on a tray, not too near its neighbour, and the tray when full must stand for several days in an atmosphere of just the right degree of cold.

I. BROOKE ALDER.

PACKING BOXES WITH CHOCOLATE AT MESSRS. FULLER'S.

WHERE GUNPOWDER IS MADE.

INNOCENT enough are the ingredients of gunpowder—saltpetre, charcoal, and sulphur. Everyone knows them and everyone can obtain them. Even schoolboys purchase them, mix them together, and have—accidents! Many a man is going about to-day bearing the marks—in the shape, it may be, of an absent finger, or indeed an absent hand, or damaged eyes, or something worse—of some youthful frolic with these simple and everyday substances. If schoolboys will have gunpowder to play with, they will be well advised if they altogether cease to make it themselves; they will, however, be still better advised if they abolish it entirely from the category of their playthings.

Grown people as well as boys are often guilty of under-estimating the danger attaching to the use of gunpowder. Not long ago a man put about a couple of pounds of powder into a hole that he had just seen a rabbit enter. He attached a fuse to the charge and lit it, expecting to have rabbit broth for dinner that day. It was his own face, however, that was nearly cooked. Another time a small box of gunpowder in pound canvas bags was put in a wash-house out of the way. A cat upset the box during the night, and part of the gunpowder was spilt among some coal lying on the floor. Next morning the servant lit the copper fire, and an explosion occurred; she was seriously burnt, and died three days afterwards. She had shovelled up with the coal the spilt powder. Wherever there is gunpowder there is danger—a fact that those into whose hands it comes do not always seem to appreciate.

THE CHARCOAL FACTORY: CHARGING THE CYLINDERS.

If the general public are thus thoughtless, fortunately those engaged in the manufacture of the explosive are not. Ever present in their mind is a sense of the danger that lurks around them, and everything they do is done subject to the observance of all the precautionary rules that knowledge and

experience can suggest. Yet the making of gunpowder, on account of the continual agitation the explosive is submitted to and the liability of machinery to break down, must *per se* be a more perilous operation than any of the simple and well-understood purposes to which it is applied. Accidents, however, are said to happen under the best regulations, and terrible havoc has been wrought in the teeth of every human provision to the contrary. Let us, however, gain a general idea of a powder factory and the processes of making powder.

REFINING SALTPETRE: THE AGITATORS.

THE MILL.

Take the factory of Messrs. John Hall and Son, Limited, the oldest and biggest, and, according to expert opinion, among the best arranged we have. It occupies that low and retired corner of Kent between Faversham and the Swale. To the passing observer it resembles a game preserve, so well fenced in, thickly wooded, and noiseless are the grounds. Yet within there are 150 different buildings, many with machinery at work day and night, and hundreds of employees go daily in and out of the gates. The buildings, which are one-storeyed, for the most part lie in hollows and wide apart, the rising ground around them confining the lateral effects of possible explosions, and the distance between them preventing an explosion in one from being communicated in any way to another. Similarly separated, in groups of two, or seldom more than three, are the operatives, so that in the case of any untoward event the number of victims is limited. These arrangements, made with a due sense of the liability of accidents to happen, are simply to confine their destructive effects. The arrangements to prevent accidents are endless. An elaborate network of canals intersects the works, and is used as far as possible for conveying the powder in the different stages of its manufacture. Water is also used wherever practicable as the motive power instead of steam. Most of the finished powder, too, is taken away by barge to the *Mariner* powder magazine anchored below Gravesend. Buckets filled with water surround every

INCORPORATING MILLS.

building, and the ground all round the danger buildings is kept moist.

The danger buildings themselves are so constructed that not a nail-head or iron in any shape is exposed, and the roofs are made slight so as to give easy vent to explosions. The garments of the workers are pocketless, so that they cannot carry knives or matches, or indeed anything, and are made of non-inflammable material. Even the buttons must not be of metal. No one is allowed to go about with trousers turned up at bottom, because grit is collected in that way, and the merest hard speck of foreign matter in a charge of gunpowder is fraught with danger. The entrances to danger buildings are protected by boards placed edgeways, so that when the door is open nothing in the shape of dirt can work in. This also serves as a check to anyone who might thoughtlessly proceed to enter without having first removed his boots and put on the overalls that are kept just inside the door. Doors are made to open outwards, so as to enable the men to escape the more readily; and on the approach of a thunderstorm the works are stopped and the operatives repair to the different watch-houses scattered over the 300 acres covered by these extensive works.

THE CARTRIDGE FACTORY.

Every week the machinery is inspected, and the reports as to its condition are printed and filed. In the case of a danger building needing to be repaired, it must first be washed out before a hammer or other iron tool is admitted to it. When artificial light is required, as in working at night or in dull weather, the lights are kept outside, being placed on the window ledges. In the case of the works magazine, which is surrounded with water, no light of any kind is ever permitted near it. These are only a few of the precautions against accidents at the works; they are sufficient, however, to show how lively must be the sense of danger. Men in powder houses usually have an arranged plan of escape in their minds, and at the least unexpected noise have not hesitated to plunge into the canal.

The component parts of gunpowder have already been mentioned—saltpetre, charcoal, and sulphur. They are mixed in different proportions, but at Messrs. Hall's works the Government standard is followed, viz. 75 per cent. of saltpetre, 15 of charcoal, and 10 of sulphur. The saltpetre comes chiefly from Bengal in jute bags, the sulphur from Sicily, and the charcoal is made on the works and mainly from the wood grown in the grounds. The saltpetre and sulphur go through various processes, such as boiling steaming, distilling, with a view to remove all impurities, not only for the sake of improving the quality of the powder, but also to keep out any foreign substances that might cause friction in subsequent operations and lead to accidents. After this, the sulphur and charcoal being ground, the three ingredients meet for the first time in the mixing house. They are put into a gun-metal or copper drum which revolves in one direction, while arms or fliers, fixed on a spindle inside, revolve at a different rate in the other direction. Five minutes of this agitation is enough for 60 lb. of the mixture, the maximum quantity allowed by Act of Parliament to be milled in one charge. After mixing, the product is known as "green charge."

At the mixing-house we come into the presence of danger, and learn that there are two kinds of floors in powder factories —"clean" and "dirty." The office floor may have just been scrubbed and be perfectly clean in the ordinary sense; still

at the factory it would be described as a "dirty" floor because anyone may walk on it in their ordinary boots. The "clean" floors, on the contrary, are usually as black as coal. They are, at any rate, as black as powder can make them, but none dare tread them except in the regulation slippers. Formerly the mixing-house was not regarded as a danger building, and its floor was consequently not deemed to be "clean." Now, however, it is so by reason of an explosion that occurred in a mixing-house whereby four men lost their lives. The

FILLING CARTRIDGES.

cause of the accident is unknown, as are the causes of most such accidents, those alone able to tell being usually killed. One witness of the explosion was about thirty yards away. He felt a concussion of the air behind him and his hat was blown off as by a strong wind. On recovering his hat he returned to the scene of the explosion. The walls of the mixing-house were blown down and the inside was in flames. A man all alight rushed out of the ruins. Buckets of water were thrown over him, but he soon expired. Three other men were found among the *débris*. A powder van, at the time of the explosion, with a canvas covering, was standing in front of the mixing-house to be loaded with charges for the mills. The horse took fright and galloped off with the van in flames. Fortunately, it took a direction away from the powder houses; fortunately, too, no powder had been loaded into the van.

From the mixing-house the "green charge" is taken to the incorporating mill. Here it undergoes a process designed to combine the different ingredients as intimately as mechanical means can combine different substances. It is spread out evenly upon a circular iron bed, "liquored" with about two pints of water to diminish the chances of ignition, and subjected to the crushing force that two iron edge runners of four tons weight each, revolving eight times to the minute, may be imagined to exercise. This pulverising goes on for from two to eight hours, according to the quality of powder desired to be made. No one need be in attendance here, and no one wishes to be, for the operation is the most dangerous in the factory; but now and then a man goes in to oil the machinery and to damp the charges. Above each bed is a water-tank, so adjusted that any force from below, such as an explosion in the bed would occasion, makes it and all the other tanks in the group tilt over and discharge their contents right upon the powder.

From the incorporating mills—of which, by the way, there are fifty at Faversham—the powder, now a dark grey or brown colour, is taken to the press-house and pressed by means of hydraulic power between copper plates into cakes about an inch thick and as hard as sandstone. This gives a certain texture to the mixture, and lends to the homogeneity already acquired in the incorporating mill. These hard cakes are next broken into pieces with wooden mallets and put through a set of breakers that reduces the pieces to the size of a walnut. The operation that finally reduces the size goes by the name of "corning," and consists of putting the pieces of cake through gun-metal rolls. Glazing, stoving, and dusting are the remaining processes. In glazing, the powder is tossed about or

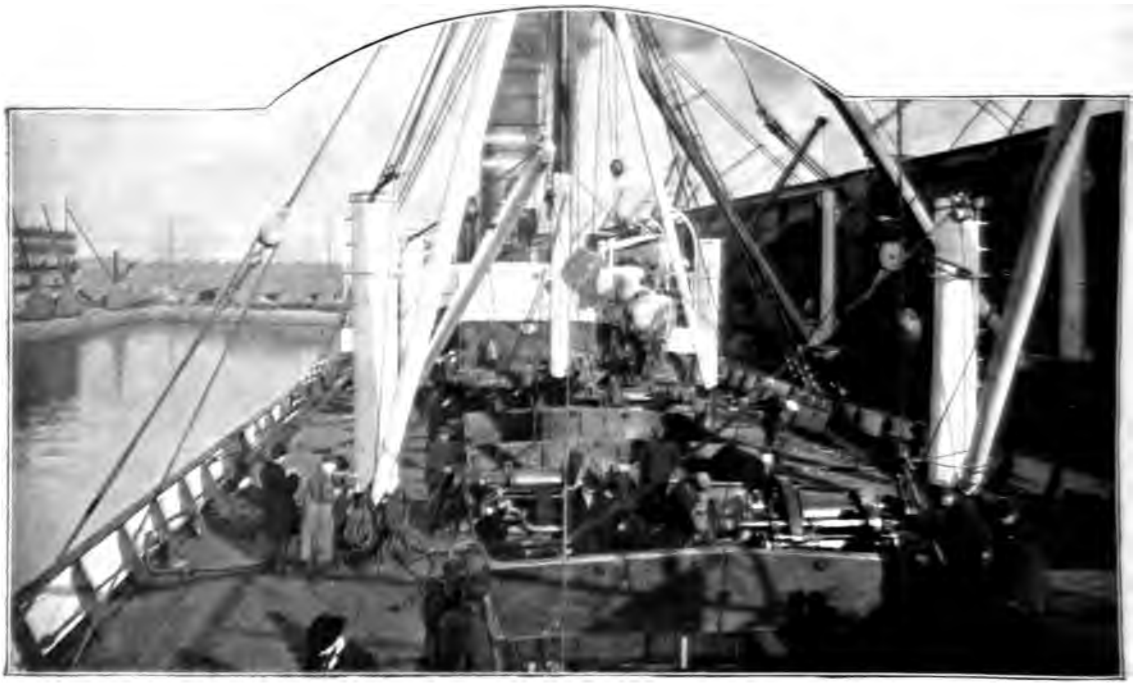
churned, so to speak, among graphite, and thereby takes on the gloss we are accustomed to see it with. Stoving is to drive off the moisture, and dusting is really sifting, whereby the powder, now in different sizes, is separated into classes according to size. It is thereafter packed into small canvas bags or canisters or barrels—all specially made—or taken to the cartridge-filling houses to be loaded into cartridge cases.

Although there are explosives made more dangerous than gunpowder, and a cubic inch of gunpowder is capable of exerting on ignition, by the gases it instantaneously generates, a pressure all round of thirty tons to the square inch. No wonder those that know it best tamper with it least! Yet with all the precautions we have seen taken in powder factories, pieces of iron, stones, and even lucifer matches have been found in barrels of gunpowder. It would be interesting and edifying to know by what means such substances got there.

Cartridge filling is also carried on at Messrs. Hall's works. This is done by women, and under all the safeguards we have seen adopted in the powder houses. The part they play is purely mechanical; nothing is left to their judgment by reason of the perfect appliances used in the process, which, though interesting, no description apart from diagrammatic illustration could render intelligible. Canisters, boxes, and barrels, which have to be of a special nature, are made on the premises. There are also smiths and millwrights, and all the different kinds of artificers required to keep the machinery in order and quick to detect flaws during the frequent inspections to which the whole works are periodically subjected.

W. B. ROBERTSON.

PACKING GUNPOWDER.



UNLOADING COTTON IN NO. 7 DOCK, MANCHESTER SHIP CANAL.

COTTON AT PORT, IN MILL, AND ON 'CHANGE.

WITHIN a twelve-mile radius of Manchester there is a population nearly as great as that of London, and the thronging people are engaged in every variety of industry. But the notion obtains that Lancashire stretching far north of the Mersey has one trade - that it deals only with cotton. Nor is this deduction altogether foolish. Though the County Palatine makes everything, from ponderous machinery to exquisite art furniture and quaintly decorated clogs, the importation, sale, carriage, unpacking, spinning, weaving, sizing, dyeing, bleaching, printing, packing, and exportation of cotton gives the widest range of employment to its busy workers.

India, now one of England's chief markets for cotton goods, was, singularly enough, not only a pioneer in steel-making, but the birthplace of the cotton industry. The trend eastward of that industry was slow. Egypt, which has, since the British occupation, developed a profitable cotton-growing in the Delta that extends, roughly, from Alexandria to Cairo and Port Said, was formerly dependent upon India for its manufactured goods. How the crafts of spinning and weaving were introduced into Great Britain is a mystery. Possibly, like the "Moonstone" in Wilkie Collins's story, they were brought stealthily, and safeguarded as great secrets. The earliest operatives were of Flemish origin, and they combed wool before they dabbled in cotton. Lancashire, chiefly because of the humidity of its atmosphere, became the great spinning and weaving ground, and as far back as the seventeenth century Manchester wove linen yarn shipped from Ireland, and worked cotton wool, bought in London, into fustians and dimities. India, meantime, aroused the bitterest jealousy of the home mill-workers by its importation of cotton fabrics; and the gentlemen of that period were taunted with flaunting in calico shirts and silk stockings from Moorshedabad! The strife between the woollen and cotton manufacturers reached the House of Commons, and the wearing of cotton garments was prohibited by enactment; yet the ladies, with charming inconsequence, delighted to walk abroad in painted calicoes!

The perversity of fashion really led to the

foundation of the cotton industry, for it was by close imitation of the Indian fabrics that the Lancashire manufacturers secured a market. Mechanical skill was concentrated on the production of machinery capable of making a yarn strong enough to be used as a warp, and invention has scarcely had an idle moment since. Kay, Wyatt, and Paul introduced fly shuttle, spinning by rollers, and carding; and Hargreaves, with his "spinning jenny," and Arkwright, with his "spinning frame," or "water frame," revolutionised the cotton industry. From his Cromford Mill, in 1773, Arkwright sent out the first British-made piece of calico; but the operatives detested his patents and methods, and rioted against the use of the "spinning jenny" and the "spinning frame." Both these machines were in turn superseded by Crompton's "mule," or "muslin wheel," and by Cartwright's power loom, and many other improvements have since been made in spinning and weaving.

English people who have read the story "Uncle Tom's Cabin" have a tolerably good idea of an American cotton plantation; but they seldom realise how vital the crop is to home industry and to national comfort. The grim incident of the cotton famine has faded from memory, and only a plantation blight, or a war with the States, could reveal to us the misery and despair that steamships without cotton cargoes, silent mills, and idle hands would mean. Still, Great Britain has not to look to America alone for its cotton supply. Egypt sends thousands of bales; and its cotton, long of staple and brown in tint, is used for the making of the finer counts of yarn. India, too, is a cotton grower, and her produce, to some extent, is manipulated in England, though the great bulk of her crop is worked up on the Continent and in India. The Indian staple is, however, shorter, and only suitable for coarser counts. The modern liking is for finer counts, and consequently the American and the Egyptian crops have the readiest market.

The American cotton crop is handled chiefly from September in one year to October in the next, but it arrives in the largest batches at English and Continental ports in November, December, January, and February. It is grown in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North and South Carolina, and Texas, and it is shipped from New York, Savannah, Brunswick, Charleston, New Orleans, Galveston, Philadelphia, Baltimore, and Pensacola. The total bulk of American cotton from a season's growth has been estimated by an expert

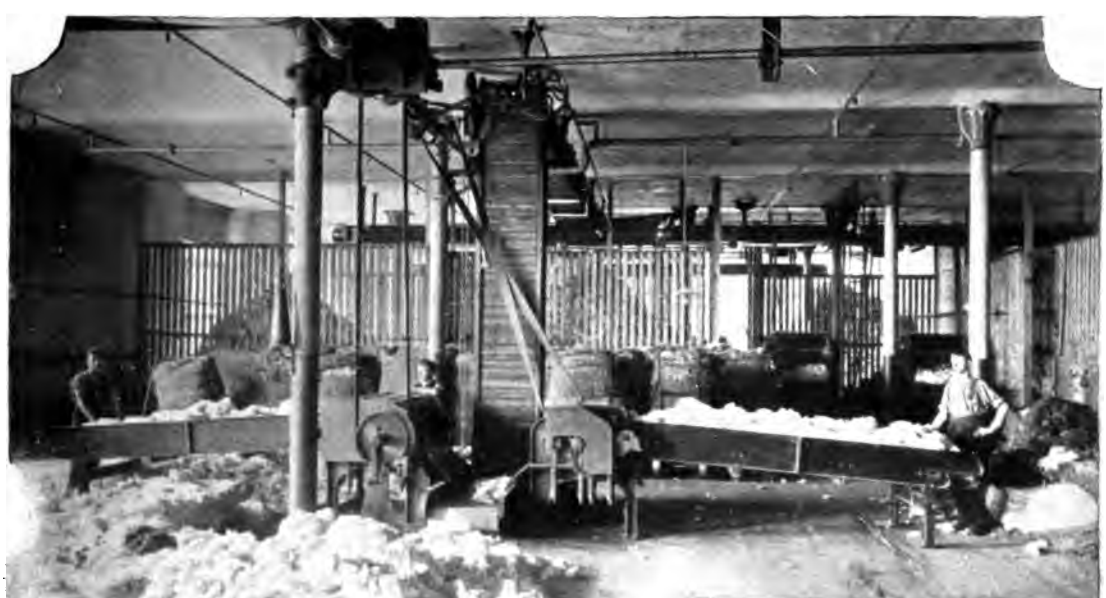


Photo: [illegible], Preston.

A COTTON-MIXING ROOM AT MESSRS. HORROCKSES, CREWDSON AND CO.'S WORKS, PRESTON.

WINDING FRAMES (MESSRS. HORROCKSES, CREWDSON AND CO., LTD.).

that so rapidly that not only spinners but manufacturers and merchants are getting in a flutter. No fewer than 30,000,000 bales of cotton will, it is estimated, be required, even within the next twenty-five years, to meet the world's annual demand for yarn and cloth; and, dependent as we are on America for our chief supply, there is undoubtedly imperative need for the cultivation of cotton in every available part of the British Empire.

The environment of a cotton mill, however picturesquely the big building has been placed in sylvan valley or by rippling brook, is apt to get dingy. Man's toil has a ruthless influence upon nature. There is an absence of verdure, as though the grass had been mistaken for cotton, and worked up in the weaving shed. The cotton mill, great or small, has been gradually pushed out of Manchester, which is chiefly engaged in the warehousing, sale, and despatch of manufactured goods. Shouldered away, as it were, by commercial energy from the city, the cotton mill has asserted itself in town, village, and dale in the vicinity, as closely as possible to the vast central market. The hand-loom weaver still

at about 11,000,000 bales, and of this quantity about 2,500,000 bales are exported to Great Britain, and nearly as much to Continental ports. Ireland, Glasgow, and Bristol have their distinctive cotton industries; but the mills of Lancashire, Derbyshire, and Cheshire take the largest share of the supply. Liverpool and the railways still do a considerable traffic in raw cotton, but the Manchester Ship Canal is also becoming a valuable agent of transit, and unloads, roughly, at the home docks, 550,000 bales of cotton yearly.

An American bale weighs 460 lb. and an Egyptian about 770 lb. The cotton product from the Nile delta is generally reckoned, however, in cantars of 98 lb. each. The supply of raw cotton from America, Egypt, and India is slightly increasing, but the consumption is increasing also, and

SPINNERS AT WORK IN A LANCASHIRE COTTON MILL.

survives in several districts, and even pursues his humble calling, amid the machinery rattle at Blackburn; but the manufacture of cotton has developed so extensively that some of the mills, fitted with the latest appliances, specialise and confine themselves solely to spinning or to weaving, or other of the many processes through which the cotton passes on its bustling way from the ship's hold to the wearer's back or into use in the household.

"You should go through a mill that does everything if you wish to get a good idea of the industry," said a Manchester merchant on 'Change to the writer. "Here's just the man. What he doesn't know about cotton isn't worth knowing!"

And, going through a spinning and weaving mill in South Lancashire, under the guidance of this shrewd expert, one was impressed by two things—the comprehensive adaptation of machinery to cotton manufacture, and the silent deftness and ingenuity of the human workers in intense heat and brain-cracking turmoil.

On entering the mill, you seem to feel that it is dominated by a great mechanical and nimble-fingered giant. The bale-breaker that mechanically opens the bale is not in use in this building; but no sooner have you, on the ground floor, noticed the huge bale of raw cotton from America or Egypt in the rough than you find it in the opening machines, which loosen its fibres and partially cleanse it. Then it is moved to the lapper, from which it emerges in fleecy roll, to claim the attention of intermediate lapper, or scutching machine. Here it is mixed, beaten, cleansed, and lapped again. In fact, it goes through a gradation of these processes, a system of stern discipline, that pounds and purifies it till it leaves the finishing scutcher in a felt-like fleece, in readiness for manipulation by the carding machines. The latter make the cotton cleaner than ever, but their chief purpose is to straighten and lengthen the fibre, which is passed through the rollers, combed or carded, fined till it is almost as delicate in texture as a spider's web, gathered in fan-like shape, and drawn into sliver, practically formed into ribbon, about an inch broad, which disappears into the revolving can in a continuous coil. On other machines it is subjected to various doublings and drawings, with the main objects of elongating and fining; and in the slubbing frame the slivers, or ribbons of cotton, are passed through rollers, and wound on large bobbins. Even then the product of the far-away plantation is given no rest. It is doubled, twisted, and wound on smaller bobbins, then passed through the roving frame, and ultimately drawn and spun into yarn in the "mule."

Photo: E. P. Carlisle, Preston.

SIZING ROOM (MESSRS. HORROCKSES, CREWDSON AND CO., LTD.).

The yarn is finished in the cop. Taking nothing for granted, the inevitable question

arises, "What is a cop?" "Well, a cop is a cop." The reply is more unsatisfactory than the one given to the more ancient query, "What is an archdeacon?" But ultimately the necessary information is evolved from the practical mind. A cop reminds one of a boy's stock of kite string. It is a long length of cotton neatly wound around a short spindle; a length of yarn built up in a form that will stand taking up and knocking about, either for sale or for further use in the mill.

Then comes initiation into the mysteries of "warp" and "weft." The "warp" is the strong thread that runs the long way of the calico, that is practically the foundation, the fabric of the useful drapery. The "weft" is the softer thread, the filling that weaves its close tracery across the warp, and gives texture to the manufacture. The warp yarn is wound around bobbin and beam in the process of weaving and warping; but it is in the sizing frame that it really gains its additional strength to bear the friction of the loom. Farina, sago, china clay, flour, tallow, paraffin wax are among many of the substances that go to make the size which slimes and thickens the thread before the adroit dropper marks its particular length and it goes on to the weaver's beam. Either the drawing or the twisting of the thread ends is necessary to prepare it for operation in the loom, and the stranger, watching the operative, a silent and swift Cagliostro, joining, as it seems, with dexterous twist of thumb and finger, the yarn ends from the healds to the thread ends on the weaver's beam, is as much impressed with the skill and concentration of the manual industry as he is with the machinery effort.

It is in the weaving shed that the latter is most assertive. There seems to be a vigorous rivalry between the over-pick looms and the under-pick looms as to which shall make the most noise. One has heard of the long arm of the law, of destiny, and of fate; but the long arm, or picking stick, of the over-pick loom is infinitely more irresistible. It stands no nonsense as it flings itself to and fro, in aggressive coquetry with the racing shuttle and the weaver's nimble fingers. A modern weaving shed, in intensity of clatter from hundreds of rapidly working looms, is a pandemonium in which gossip by voice is impossible, for Jove the thunderer could not make himself heard in the din. He would have to become mortal, and, adopting the adroit method of the weaver, speak by signs, by the silent but expressive movement of the lips. Yet the huge shed is an enlightening place. You note the skilful tend of loom by weaver, the strike of the picker, the lightning shoot of the shuttle, and the move of "slay" and shuttle, pressing each thread of weft forward to the warp, deftly weaving the cotton cloth, which a few days hence will be on shipboard for export or on draper's counter.

Calico, or cotton cloth, is worked up in a thousand ways to make the infinite variety of Manchester goods for home use and export, and in calico printing art and invention help industry in the manufacture of attractive fabrics, one of the modern developments being the application of electricity as a motive power to drive the machines. One of the most interesting manipulations of cotton is that by which it is converted into the familiar "flannelette." The cotton made from coarse counts is subjected to a "teasing" or "raising" process, which fluffs the fibre from the yarn, and produces a material soft and warm to the touch, like flannel, and yet much cheaper. Its price has brought it into use in nearly every home of limited income, and the poorest folks, unable to purchase the best quality flannel, are warmly clad by the imitation. But the material is always in a vortex of controversy. Many a coroner has condemned it because it is easy of ignition. Many a maker has eulogised it on the plea that flannelette, quarter the cost of flannel, is indispensable to the comfort of the working classes, and that the loss of life by burning fatality is more than counterbalanced by the virtue of its wear as a safeguard against colds, chills, and pneumonia. Fortunately the controversy may soon be set at rest. Scientific experiment has strengthened the position of the manufacturer; and it is claimed that flannelette, by chemical agency, can now be rendered non-inflammable!

The cotton mills of Lancashire contain, roughly, 44,000,000 spindles and nearly 700,000 looms, employing at least half a million hands, and there are, in addition,

Photo: Cassell & Co., Ltd.

WEAVERS AT THE LOOMS

[illegible]

A WEAVING SHED AT THE WORKS OF MESSRS. HORROCKSES, CREWDSON AND CO., LTD.

Photo: Beattie & Co., Preston.

A SHEETING WEAVING SHED (MESSRS. HORROCKSES, CREWDSON AND CO., LTD.)

many other mills and factories that spin and manufacture textile fabrics. Practically 2,000 firms are engaged in the cotton industry, and there is scarcely a country, civilised or barbarous, to which the output, fine or coarse, gaudy or plain, is not sent.

The tendency in the cotton industry is towards better working conditions and shorter hours. Even steaming in weaving sheds, which some manufacturers consider vital to the make of cotton cloth, may ultimately be legislated out of the mill. Meantime the operative adapts himself to new methods of work, and his old pugnacity in social life has been superseded by homely philosophy and quaint humour. On his annual holiday, in the "wakes week," with his savings from the "going-away club" in his pocket, he is a plutocrat, notwithstanding his hearty ways and whimsical dialect. But it is on 'Change that the wealth and power of the industry is the most impressively indicated.

The great "cotton lords," once wealthy and influential enough to arouse Bismarck's envy, have not altogether disappeared from "the boards." But the trade has gradually diversified and extended till there are 8,000 three-guinea subscribers to the Manchester Royal Exchange, the largest exchange in Europe. Nearly all these men are engaged in selling or buying cotton, raw or manufactured, or doing business in some commodity necessary for the equipment or work of mill. The scriptural reminder that a good name is better than riches has been placed high up in the gilded dome of the vast hall. More easily within the range of vision are the latest quotations for consols, the bank rate, and the cotton prices. The telephone, the telegraph, and the special messenger are so alert that there is no longer necessity for the merchant to signal the state of the market, whether buoyant or depressed, by the tip backward or forward of his silk hat. The great throng on 'Change know to a fraction how far to go in business enterprise. They have their fingers on the commercial pulse of the world, and they make the most of "the golden moments in the stream of life."

JOHN PENDLETON.

CLERKS.

Photo: Cassell & Co., Ltd.
A BARRISTER'S CLERK.

AS Great Britain enjoys the commercial supremacy of the world, it follows as a matter of course that her manufacturing cities and towns provide a field of extraordinary range for clerical employment. An ever-increasing army of Englishmen are engaged in keeping the ledgers which are literally detailed charts of our gigantic trade. And their ranks are annually supplemented by an influx of foreigners, principally Germans and Frenchmen, who remain here only long enough to master the language, our methods of doing business, and the nature of our world-wide commercial connections, before returning to their own country to use the knowledge thus acquired against their instructors.

Boys destined to become clerks generally enter offices at any age from twelve to fifteen. Every class supplies its quota of recruits. The public school lad is often sent into the City in the hope that a business training, backed by social influence, may secure him a dignified and lucrative position in the higher walks of commercial life. The Board school, however, furnishes the majority of embryo clerks. The office-boy stands at the foot of the ladder, so far as the clerical industry is concerned, and his services are generally valued at about five or six shillings a week. The day may come when his income will be reckoned by hundreds, even by thousands. But the ladder which he has to climb has many gradations. He begins by acquiring a knowledge of office routine. He is expected to reach the counting house in the morning before his seniors. He indexes the letters, takes charge of the stamps, and goes on errands if required. It is all very simple, very monotonous, but the discipline is priceless in preparing him for a life in which brilliancy is useless in comparison with accuracy, honesty, punctuality, neatness, and character. In every office, even those devoted to the same line of trade, the daily round of duties differs in details. But sound business principles, like Euclid's axioms, are a fixed quantity.

There are, in round numbers, 150,000 clerks in London, or practically twice as many as in any other European city, and the proportion probably also holds good even in the case of New York. Economic causes suffice to explain the rush for clerkships. British trade is now represented by an annual turnover of about £900,000,000 sterling. In proportion as trade expands, as the figures, neatly arranged in the form of national export and import returns, attain to more and more bewildering dimensions, employment for clerks multiplies. For it must be remembered that the petty totals, which in the aggregate amount to these colossal millions, have to be cast up, and cast up again, checked, and audited by hundreds of thousands of youths and men, ere they flow through one channel or another into the hands of Board of Trade officials, to be thrown into the form of Blue-books. The clerical industry differs from every other in that no form of trade is independent of it. The world-wide contractor, the millionaire company-promoter, the West-End shopkeeper, the East-End huckster, as well as the thousand types who fill the gaps between these strongly marked representatives of the commercial classes, all have to

Photo: Cassell & Co., Ltd.
A "WALK" CLERK.

Photo: Cassell & Co., Ltd.

MAGISTRATE'S CLERK, MARYLEBONE POLICE COURT.

requisite clerical help in the conduct of their business. Eliminate clerks, in fact, and, despite railways and telegraphs and ocean greyhounds, British commerce becomes automatically divested of its cosmopolitan character.

As more clerks are generally required to cope with the transactions of a joint-stock company than with the business of a private firm, it follows that the general tendency towards the limited liability system of ownership is advantageous to the clerical industry. The railways, the ocean carrying trade, the shipbuilding yards, the coal mines, the cycle factories, the breweries, and engineering works throughout the kingdom, are, as a rule, in the hands of public companies, who employ in all more than half a million clerks. Quite distinct from these great centres of employment is the shopping world—wholesale and retail. It must not, of course, be supposed that the Whitechapel trader who does business chiefly in halfpence and farthings employs even one bookkeeper permanently. One of his children generally enters roughly the daily transactions. The assistance of a regular clerk is then occasionally requisitioned, that he may obtain a clear statement of his financial position. The clerks who perform these odd jobs are sometimes men who never seem able to retain regular employment. On the other hand, they are often bookkeepers in fairly good situations, who adopt this method of turning their leisure to profit. Certain positions are now reserved for ladies in almost every large mercantile establishment. Shorthand and typewriting are the lady-clerk's most usual qualifications for employment. Numberless as are the sources of occupation open to clerks, nevertheless, very many men are constantly unable to find positions. The reason is twofold. Cheap education has placed within the reach of all the necessary intellectual equipment, and many parents cannot resist the temptation thus thrown in their way to put their children to employment which means an immediate addition to the family exchequer of some trifling weekly sum. In the second place, there is no such protection against undue clerical competition as is afforded to all classes of skilled mechanics by their trades unions. This is a state of things which cannot very well be remedied, for in ordinary mercantile work there are no long apprenticeships to be passed through, no highly technical knowledge to be acquired.

Custom requires that the clerk shall dress

better, and generally live according to a more pretentious scale, than persons who earn at least as much and often considerably more. The poorer members of the craft are in this way called upon to make sacrifices and endure deprivations calculated to break the finest spirit. No city in the world presents such heart-rending extremes of luxury and poverty as London. And amongst the class whom we are now considering are to be found, perhaps, the most painful contrasts. Any day one may notice in the City the shabbily attired clerk munching furtively the sandwich which he has brought from his home in the suburbs to serve as luncheon. He is very possibly married, and has to support a family on twenty-seven or thirty shillings a week. To him every penny counts. His single brother, earning only the same salary, or even a little less, can always afford a substantial luncheon at a respectable restaurant, and manage to keep himself attired smartly.

Travelling to and from business necessarily imposes a heavy drain upon the pocket of the metropolitan married clerk whose income approximates to that just mentioned. It is practically impossible for him to obtain cheap and suitable living accommodation within walking distance of his work. He is therefore almost compelled to take up his residence in a suburb. The railway charges for season tickets may appear trifling to the well-to-do, but the humble clerk with a family dependent on him cannot always afford to become a season ticket holder. He endeavours to effect the needful economy by travelling by the workmen's trains, a course which involves leaving home much earlier in the morning than would otherwise be necessary. In the wear and tear of metropolitan life every hour added on to the working day counts. In this respect the provincial clerk enjoys a distinct advantage over his London brethren. It is noteworthy, too, that the salaries paid to the rank and file of clerks in the provinces are substantially the same as those paid in London, notwithstanding the difference in the cost of living. But, of course, opportunities for advancement are clearly proportionate to the importance of a town as a centre of trade and industry.

The Stock Exchange articled clerk belongs to the aristocracy of City clerks. He makes anything from a hundred a year to five hundred, and by-and-by will probably develop into a full-fledged stockbroker.

All grades of Stock Exchange clerks are in the satisfactory position of possessing special knowledge of a highly technical branch of commercial life. This in itself tends to limit competition, which is a distinct gain from the employee's point of view. Railway clerks also enjoy agreeable immunity from the difficulties which beset the ordinary mercantile clerk. Appointments in most of the railways are made from the ranks of

TOWN CLERK (BATTERSEA).

Photo: Cassell & Co., Ltd.

youths nominated by the directors. The working of a great line is an exceedingly complex matter. And the boy who takes an interest in his work has plenty to learn. Heavy demands, however, are made upon his patience as well as upon his intelligence, if the special department in which his duty lies brings him into direct contact with the travelling public.

The Government service in every country is generally regarded as a sort of earthly Elysium for clerks. There are no earthly Elysiums! But this particular delusion is easily understandable, seeing the keen competition which is waged for all vacancies in the Civil Service, whether the clerkships be in the House of Lords or in His Majesty's prisons. Thousands of boys annually compete at the various examinations, and thousands of necessity fail, falling back, as a matter of course, upon the already congested battalions of mercantile clerks. Civil Service tutors probably turn over a couple of hundred thousand pounds a year from the fees of aspirants to State clerkships. Great Britain pays her servants all round better than any other country. But amongst them are the well and the poorly paid. A junior clerk in a country post-office often has to make ends meet on twelve shillings a week. Hundreds of boy-copyists employed in the Government departments in London, Dublin, Edinburgh, and other important towns receive very little more for their services from an appreciative country, notwithstanding that their appointments have been obtained by competitive examination, with the prospect of another examination when they reach the threshold of manhood, failure in which involves the loss of State employment. The Government clerk enjoys an advantage over all others in the matter of working hours. From ten to four he is bound to his desk; but as soon as the clock strikes he is free. The mercantile clerk, on the other hand, often works from eight until six or even seven. At times of exceptional pressure Stock Exchange clerks are busy until close upon midnight, but they are always paid well for overtime when such an exceptional strain is imposed upon them. The Government servant is relatively independent of the whims of his superiors, and the "fixity of tenure" which he thus enjoys, coupled with the certainty of a pension in his declining years, constitute, doubtless, the most substantial advantages of his position. The two or three pounds a week allowed a brilliant young University man when he succeeds in entering the first division of Government clerks cannot be described as a handsome return for the use of his brains. The future, however, may bring him a post of real worth, perhaps of distinction, while at the worst he is certain to be drawing within a reasonable time a salary of several hundreds a year. Clerks of the lower division can rarely, however, look forward to the excellent appointments which occasionally come to the men who begin life in the higher branch of the service. The Foreign Office clerk is a prince amongst his kind. His official salary is generally but a small fraction of his income.

A LADY TYPIST AT WORK.

The Law provides more satisfactory employment for the rank and file of clerks than, perhaps, any other line of business. A good lawyer's clerk is a man with special knowledge, much of it of a highly technical character, which has been acquired by years of patient industry. He is a skilled worker who commands a good wage and cannot be

Photo: Cassell & Co., Ltd.

INTERIOR OF BOOKING OFFICE, LONDON BRIDGE STATION (LONDON, BRIGHTON AND SOUTH COAST RAILWAY).

Photo: Cassell & Co., Ltd.

CLERKS STAMPING ENVELOPES AT SOMERSET HOUSE.

easily replaced. Well-organised societies exist for the protection of law clerks' interests. A solicitor enjoying a remunerative practice often has for his senior clerk a qualified solicitor—a man, perhaps, who started on his career as an office boy. The shorthand clerk is a valuable member of every successful lawyer's staff. For some reason or other lady clerks have not yet invaded to any considerable extent the lawyer's office. But as scriveners' assistants they find plenty of remunerative work in all the great legal centres. Every Court in the realm has its clerk, while the High Courts of Justice have a battalion, certificated by the Civil Service Commissioners, most of whom are never seen in court, their work being connected rather with the machinery of the Law than its administration.

It is difficult to conceive any body of men weighted with greater responsibility than bank clerks. Not only is banking itself a great industry, but those who conduct it have under their hands at all seasons the very life-spring of all industries. Neither the great capitalist, master of millions of money and the happiness of thousands of people, nor the humble marine-store dealer can dispense with the bank clerk's services. It is one of life's ironies that bank clerks are very indifferently paid. Day after day cashiers in a hundred London banks, and in a thousand banks throughout the country, pass over the counter, within, perhaps, an hour, sums of gold equivalent to many years' purchase of their salaries—sums which would make them rich for life and their children after them. Considering their temptations, they have good reason to feel more than proud of the confidence which the commercial world reposes in their integrity. The vacancies

Photo: Cassell & Co., Ltd.

LADY CLERKS AT A LONDON POST OFFICE.

for juniors in most banks are filled by youths nominated by the directors. In some instances the initial salary is only thirty pounds a year. It is not unusual for the manager of a branch house of an important banking company to draw a salary hardly so good as that of a second-rate music-hall performer. Not often does the bank official reach a salary of a thousand per annum.

Municipal clerks are not only well paid, but are, as a rule, accommodated with bright, airy offices and are seldom overworked. Town clerks, of course, are at the head of this department of the clerical industry. The Town Clerk of the City of London measures his salary by thousands. The town clerks of few important towns draw less than eight or nine hundred per annum. The London boroughs pay their town clerks handsomely, salaries of a thousand pounds and upwards being quite the rule. In some small county towns, however, the town clerk ekes out a living by combining the practice of a regular profession with his municipal duties. In municipal life a clerk of exceptional ability seems to advance more rapidly to the higher ranks than is the case in other spheres of clerical employment. It is but necessary, however, to look round on the list of leading men in all departments of business, and in some of the professions, to realise that every clerk has hidden somewhere in his desk the key to wealth and position. It only needs finding.

P. F. William Ryan.

CLERKS AT WORK IN A SHIPPING OFFICE (ELDER, DEMPSTER AND CO., LIVERPOOL).

THE ART AND "MYSTERY" OF SCENE-PAINTING.

SCENE-PAINTING is, of course, an art as well as an avocation. The scene-painter, it is true, can aim only at broad effects; delicacy and subtlety he must not attempt. And to the conventions of the ordinary painter he has to add others arising out of the circumstance that his work has to be viewed from a distance, and not only in artificial light, but often in artificial light that is tinted. This, however, does not make his work less an art; it is one difficulty the more to overcome; and the best scene-painter, other things being equal, is the one who most successfully adapts his art to all the manager's exacting requirements.

Photo: Cassell & Co., Ltd.

A SCENE-PAINTER'S PALETTE (MR. HEMSLEY'S STUDIO).

In these pages, however, it is with scene-painting as an avocation rather than as an art that we are primarily concerned. That those who rise to distinction in the profession are not unhandsomely remunerated for their skill and pains may be taken for granted. In these days so much depends upon the "mounting" of a piece—audiences have, as a result of long indulgence, come to expect so much in the way of scenic beauty—that it would be strange indeed if the men whose function it is to supply the demand had to complain of inadequate recompense in current coin. Nor does the work fail to bring some measure of glory to those who are mainly responsible for it. Such names as Hawes Craven, Joseph Harker, Bruce Smith, W. Telbin, R. Caney, W. Harford, Henry Emden, W. T. Hemsley, T. E. Ryan, and Walter Johnston are almost household words among that largest of all "the classes" who frequent the theatres. A fleeting kind of fame, no doubt. But so also is that of the actor. The greatest of those who tread the boards and nightly move multitudes to ecstasy have no sooner quitted the scenes of their triumphs than they begin to fade into abstractions, and if they remain anything more than mere names it is at least as much because, like David Garrick, they were personalities as on account of their histrionic genius.

Although some of the big cities of the provinces, such as Liverpool, Manchester, and Birmingham, have their own scene-painters, the great centre of the profession is London; and it is the scene-painters of the metropolis who for the most part furnish forth the scenery for those touring companies that carry successful plays into the country. Yet even in London—and even though during the last few years theatres have been springing up all over the town—the number of scene-painters is not considerable. Painters and assistants together do not, probably, number more than about a hundred. To these must be added the articled pupils; and although many of these have acquired a considerable degree of proficiency, one still marvels how so small a body of men contrives to get through such an enormous mass of work. In former days each leading theatre had its own staff of scene-painters; now the rule is for the scenes to be distributed among several artists, regard being had, of course, to the special aptitudes of

Photo: Cassell & Co., Ltd.

A SCENE-PAINTER AT WORK (MR. JOSEPH HARKER).

each. How the change came about, whether it was that the modern system of long runs made it uneconomical for a theatre to have its permanent staff of scene-painters, we need not stop to inquire, but so it is. A scene is offered to a given artist, a price is agreed upon, and he, with his assistants and pupils, turns out the work.

Another change, consequent upon the one just indicated, is that the work is no longer for the most part done in the theatres, but in buildings rented or acquired by the various artists, and by them adapted to their requirements. Almost the only exception to this rule is Drury Lane, which is such an enormous structure that there is room in it for at least some of the scenes that are presently to grace the stage to be painted "on the premises." At Drury Lane, indeed, there is room for everything. Other theatres have to store their scenes in railway arches, and so forth, and my readers will doubtless remember how not so very long ago a fire in one of these arches wrought havoc among the beautiful scenes which Sir Henry Irving had accumulated; but Drury Lane is able to provide its own storage, although, as may be supposed, its stock of scenes and "properties" is on the most gigantic scale.

This leads me to speak of yet another change that has come over the "mystery" of scene-painting. Formerly the canvas was spread on the floor, and the artist traced his designs with a brush having a handle long enough to permit of his standing over his work. The inconveniences of this *modus operandi* are obvious enough. In the first place, the work could only be done in a building with a large superficial area. The Covent Garden Opera House requires scenes seventy feet long by forty feet broad, and though the stage of Covent Garden is the largest in this country, scenes for an average theatre have to be some forty feet by thirty-five feet. The position, too, was an awkward and tiring one for the painter, who must have known excellently well what backache means, and who was also reduced to the painful necessity of treading his work under foot. Now all these drawbacks are avoided by the simple expedient of a windlass and a slit in the floor, through which the canvas, attached to a frame, is raised or lowered so as to bring that part of it which is being operated upon at the moment on a level with the painter's arm.

It is still necessary, of course, that the painter should have a fairly lofty building to work in, but he requires comparatively little floor space. In Macklin Street, between Holborn and Drury Lane, a large warehouse has been converted into painting rooms by two well-known scenic artists. Other scene-

Photo: Cassell & Co., Ltd.

GRINDING THE COLOURS.

[illegible] with inferior [illegible] and roughly, the [illegible] aims, perhaps, at [illegible] than his English [illegible] require a robust [illegible] that they are less [illegible]

[illegible] with help [illegible] indicated

Photo: Cassell & Co., Ltd.

IN A SCENE-PAINTER'S STUDIO (SHOWING THE BRIDGE AND THE METHOD OF RAISING AND LOWERING IT).

not, of course, monopolise the contracts given out by these two theatres, since he is only capable of doing the work of two or three men and not of a round dozen—does some of his painting at Drury Lane; and, as he is one of those who can do two things at once, friends who call upon him here seldom find him too busy to have a chat.

Before passing on to describe how scene-painting is done, I should mention the rather curious circumstance that our ingenious neighbours across the Channel still paint on the floor. That they produce good results, at whatever inconvenience to themselves, may, to use one of their own idioms, go without saying, for so artistic and theatre-loving a nation as the French

the kind of scene he requires, the scene-painter makes a sketch, and if that is approved he proceeds to construct of cardboard a complete model, on a scale, say, of half an inch to the foot. It is here that the resourcefulness and inventiveness of the scene-painter are able to make themselves felt. The model shows everything, down to the smallest detail—not only the landscape, but door and windows, those which have to open in the actual scene being made "practicable" in the model. "Wings" and "top-cloths" are also shown, and even the pulley and ropes which will be used in the adjustment of the scene are indicated. This part of the work, as may be supposed, calls for abundant

Photo: Cassell & Co., Ltd.
SHIFTING THE SCENES.

patience, but its importance is manifest, and no scene-painter begrudges the time he has to spend upon his model, even when he knows that he will have to toil early and late to get the work finished by the stipulated time.

The model, when at last it is completed, is submitted to the manager's consideration. It may be that he or the author desires some alteration, generally an inconsiderable one. When the modification has been made, the model is handed over to the master carpenter, who constructs the framework which is to receive the canvas. Having been affixed to the frame, the canvas is prepared by the painter's labourers, whose business also it is to mix the colours. These are ground in water, by means of such a machine as is figured in one of our illustrations. Now the artist draws the design in chalk or charcoal, and then the colours are filled in, always, as I have said, with due regard to the artificial conditions under which the picture has to be viewed, certain colours, therefore, which appear very differently in artificial light as compared with natural light, being avoided altogether, or modified, as the case may be.

That scene-painting, like most other modes of earning one's daily bread, is not

Photo: Cassell & Co., Ltd.
A SCENE-PAINTER (MR. RYAN) AT WORK ON A FOREST SCENE WHICH IS LOWERED OR RAISED THROUGH THE FLOOR AS OCCASION DEMANDS.

without drawbacks, I am not prepared to assert. Strange indeed would it be if this were not so. The work, as the reader will know for himself, has a plentiful lack of regularity, and while both master painters and assistants often have to toil under heavy pressure to get their scenes ready by the eventful night, the assistants, at any rate, sometimes have periods of enforced leisure. The attractions of the vocation, however, to those to whom the work itself is congenial, far out this disadvantage. If the practitioner art is clever and resourceful, if h not only wield the brush swiftly deftly, but is also facile in inventi scene from the manager's brief hints, is a much rarer gift, he in no long may rise to distinction, besides being lib rewarded in a pecuniary sense for his ind and skill.

W. WHEEL

A FINISHED SCENE (MR. RYAN'S STUDIO).

Photo: Cassell & Co., Ltd.

RAW MATERIAL FOR THE BRITISH ARMY: RECRUITS AT ST. GEORGE'S BARRACKS.

EVERYDAY LIFE IN THE ARMY.

ALTHOUGH our foreign neighbours are never tired of sneering at the alleged mercenary basis of the British military system, there can be no doubt as to the latter—that is, the voluntary system—being a higher development than that of compulsory service. It would, of course, be too much to say that the great majority of men enlist out of purely patriotic motives; nevertheless, the very fact of their enlisting of their own free will confers upon the British Army a quality of spirit and tone which are of incalculable value. Concerning the advantages—not realised as widely as they should be—which the Army now offers as a means of employment we shall speak farther on; meanwhile, to commence the description of everyday life in the Army, let it be at once stated that the training of men by short service and passing them into the Reserve is the vital principle of the system.

The mass of men—that is, those for the Line, Cavalry and Infantry, and the Royal Artillery—enter the Army for seven years with the colours and five in the Reserve; or eight years with the colours and four in the Reserve, if the period of Army service expires while the man is abroad. The Foot Guards and the Royal Engineers have the option of the foregoing, or of three years' Army and nine years' Reserve service and an additional year of service abroad. All recruits for the Army Service Corps enter for three years' Army and nine years' Reserve service. In time of war or great emergency, however, all soldiers can be detained for twelve months beyond their engagement. The Army Reserve is that force to which men are transferred on the expiration of their period of service with the colours. Men serving at home may, should the exigencies of the service permit, be allowed to pass into the Reserve after five years' service. On the other hand, re-engagement for further service with the colours is encouraged. All soldiers serving with the colours who are medically fit may re-engage to complete twenty-one years' service: Warrant officers and sergeants after nine years' service, subject to the approval of the Secretary of State for War; corporals, bombardiers, bandsmen, and artificers, after nine years also, by permission of the commanding officer; and all other soldiers of good character after eleven years' service.

A recruit is enlisted for any regiment of cavalry or infantry for which the recruiter to whom he offers himself is authorised to raise men; or he may enlist for general service in the cavalry or infantry, in which case he is appointed to a regiment, but is liable to be transferred within three months of the date of his attestation to any corps of the same arm of the service. The requirements as to age and height are varied from time to time, and may be obtained at any recruiting station.

All manner of classes are represented by the recruits, whose reasons for enlisting are multifarious, although, broadly speaking, the matter is regulated by the state of the labour market. By the Army Act of 1881, the recruit no longer receives the "King's Shilling," which formerly obliged him to appear before a magistrate and take the oath, or pay a fine of £1. Now he is not deemed to be enlisted until he has voluntarily appeared before a magistrate, or other authorised person, who puts to him a series of authorised questions and satisfies himself that the man is not under the influence of liquor; while the recruit's first ordeal takes place before the doctor, who has him stripped, weighed, measured, tested in eyes and ears, and put through many motions. Having passed the doctor, the recruit is sent, wherever possible, to the depôt of his unit, where provision is made for his preliminary instruction, and where he receives his clothing, necessaries, and equipment.

Photo: Argent Archer, Kensington.

ENGINEERS LAYING A SIEGE RAILWAY.

The clothing, which means uniform, is issued in sizes from the Pimlico establishment, and the recruit is fitted by the sergeant master tailor, and subsequently paraded before the commanding officer, to receive the latter's approval. The necessaries comprise shirts, socks, brushes, comb, razor, knife, fork, spoon, button brass, and tooth brush (the last named only recently added), which the recruit receives free on joining, under the name of a "free kit," and which he has to keep up at his own expense. The term equipment applies to the articles such as arms, valises, belts, ammunition pouches, etc., which are issued by the Ordnance Store Department to the commanding officer of the unit, according to its establishment. The soldier, if transferred to another unit, does not take his equipment with him, unless it is specially transferred with him.

The idea of sending the recruit to a depôt is that he may be gently broken in, so to speak. The depôt officers and non-commissioned officers, who give him his first instruction, are carefully selected, and he associates with old soldiers of good character, who will put him up to things, and show him how to clean, fit, and arrange his arms, accoutrements, and kit. The infantry recruit joins the regimental depôt, where he remains, as a rule, about three months, undergoing the recruit's courses of drill and musketry instruction.

Photo: Cassell & Co., Ltd.
IN A MILITARY RIDING SCHOOL.

At the expiration of the depôt term recruits are despatched in drafts to a battalion of their regiment serving at home. In the case of the cavalry, however, the recruit is sent straight to his regiment, unless it happens to be abroad, when he joins the cavalry depôt at Canterbury. The cavalry recruit has to learn the use of the carbine, sword, or lance, and to practise on foot the different formations of cavalry, before taking his place in the mounted ranks. Simultaneously with this drill he is performing stable work, learning fencing, and going through a gymnastic course. All this lasts fully two months, after which he is handed over to the riding master, to undergo a course of 120 lessons, or thereabouts. The riding-school course is, indeed, a most thorough one. For some forty lessons the young soldier has to ride without stirrups, for in no other manner can the strength below the waist and the balance and grip be acquired; then follows practice in riding without reins at a trot or canter, his arms folded, and leaping; while the last part of his training is devoted to teaching him how to use his weapons in the saddle. Dismissed riding school, the young cavalryman has only to pass through the musketry course, and he has qualified as a trained soldier.

In the Royal Artillery the course of instruction has necessarily numerous peculiar features of its own. In this branch of the service the soldier is either a gunner or a driver, and both must learn to march and undergo schooling and gymnastics. The

IN THE GYMNASIUM.

Photo: Argent Archer, Kensington.

driver must be instructed in riding, driving, fitting and care of harness, and the care and grooming of horses. The gunner of each branch—Horse, Field, and Garrison Artillery—is taught to serve, lay, and fire his gun, and how to dismount, move, and mount it. The horse gunner is also taught to ride; while the garrison gunner has to be instructed in the care of stores, magazines, and ammunition, and eventually to know all about range- and position-finding instruments, combined with no mean acquaintanceship with hydraulics, machinery, and electricity. In the Royal Artillery, therefore, men are classified as 1st, 2nd, or 3rd class, according to professional knowledge; and certain appointments can only be held by first-class gunners.

All men who enlist for dismounted units of the Royal Engineers must have a specified trade. The scientific corps, as it is correctly termed, comprises various branches which, from their names alone, signify the possession of considerable technical skill. There are bridging battalions; telegraph companies, provided with portable telegraph and telephone material; field depôts, comprising a field park with apparatus for printing, photography, etc., and a mounted detachment, supplied with tools and explosives for destroying railways, roads, and bridges; field companies, ready for any engineering work; balloon sections; railway companies, one of which is stationed at Woolwich and is employed on the arsenal railways, and another at Chatham, where it has charge of a Government line; fortress companies, whose duties are confined to the construction, attack, and defence of fortresses; and submarine miners, attired more like sailors than soldiers, who see to the defence of our harbours and tidal estuaries.

The Army Service Corps is composed of clerks, artisans, drivers, butchers, bakers, and shoeing smiths; the Army Medical Corps is a trained body of men whose duties as hospital orderlies and bearers need not be dilated upon, and the corps of Ordnance artificers provides qualified artificers for the repair and maintenance of the material belonging to the Garrison Artillery siege train, etc. To join the last named men must be of good character, competent fitters with some knowledge of mechanical drawing, and serve on probation for a year.

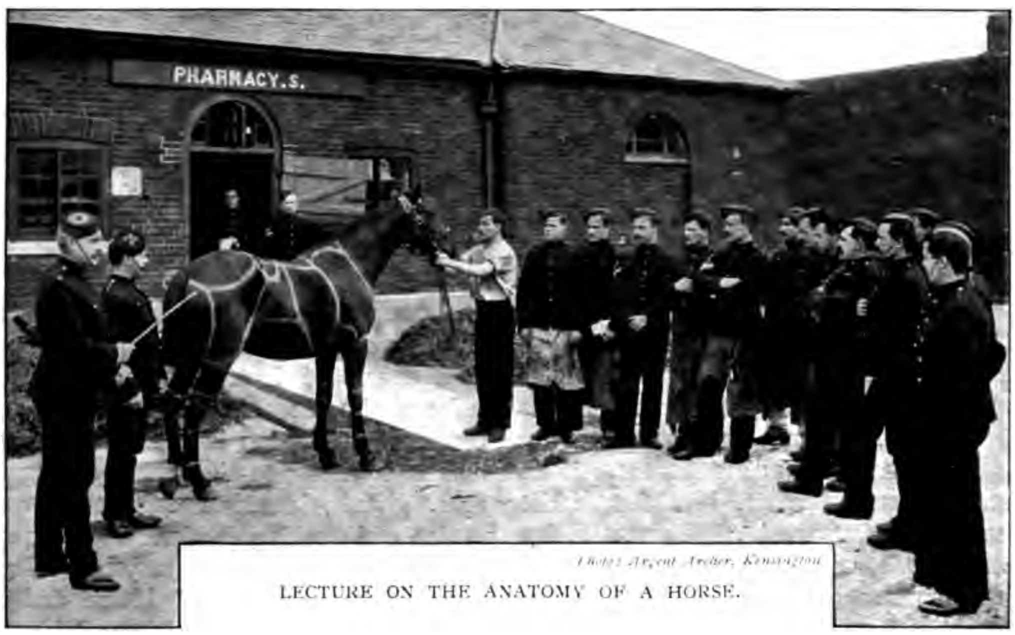


Photo: Argent Archer, Kensington.

LECTURE ON THE ANATOMY OF A HORSE.

The everyday life of a soldier may be said to commence at 6 a.m., and terminate at 10 p.m. with "Lights out." His actual working hours, however—guards and fatigues excepted—may be approximately given as from 6 a.m. to 3 p.m. The reveille sounding is the signal for the troops to rise and

Photo: Wyrall & Son, Aldershot.

INTERIOR OF BAKERY, ARMY SERVICE CORPS.

to clean and arrange their barrack rooms or tents under the superintendence of the non-commissioned officers; and later on, usually about 10 a.m., the barrack rooms or lines are inspected by the company officers. In the summer months there is an adjutant's parade before breakfast, while between breakfast and the commanding officer's parade, which is the event of the day, the function known as orderly room is held. At orderly room soldiers guilty of offences are brought up before the "C.O.," who investigates their cases, and punishes or admonishes as the case may be. After the "C.O.'s" parade comes the dinner-hour, and after dinner another short parade, usually conducted by the sergeant-major, and attended only by the young soldiers. The foregoing remarks apply more especially to the infantry. In the cavalry and horse artillery riding school or exercise takes the place of the early morning parade, while with all mounted units there is a routine of stable duties on return of horses from work. Of course, the duties vary somewhat on different days of the week, and the routine is posted up in the barrack rooms, detailing the succession of parades and duties for each day of the week. Between March 1st and October 31st, known as the drill season, one company in each infantry battalion at home is struck off all duties for the purpose of a course of instruction under its own officers, known as field training. The course of instruction lasts about four weeks, and comprises fire discipline, advance and rear guards, reconnoitring and outpost duties, and working parties. Each squadron of cavalry, every company of Garrison Artillery, all batteries of Horse and Field Artillery, and all companies of Engineers are struck off all duty for a similar period for the purpose of going through an annual course of instruction, according to the syllabus promulgated in regimental orders. Then again every unit of cavalry, infantry, Garrison Artillery, and Royal Engineers has to be exercised through a course of musketry and field-firing, the latter being made as interesting and realistic as possible. Great importance is attached to gymnastic instruction, both for the forming of recruits and for hardening and strengthening the trained soldier, so as to enable the latter to cover 1,000 yards at a rapid pace, and find himself in good wind and able to use his bayonet efficiently. The gymnastic instruction of trained soldiers, however, is carried on so as to interfere as little as possible with their ordinary duties. Every

infantry battalion must have six, and every cavalry regiment twelve, qualified signallers, under an officer instructor; while special subjects taught cavalry soldiers are anatomy, reconnaissance, and sketching. Lastly, where both infantry and cavalry are concerned mention must be made of the special instruction imparted to the machine-gun detachment, and where the infantry alone are concerned of the practice in progressive route marching during the winter.

It is not realised what a good time soldiers generally have. What with his pay, rations, lodging, and clothing, the young soldier on joining receives the equivalent of 15s. a week. He gets three meals a day, viz. breakfast, consisting of a large bowl of tea or coffee, part of his day's bread ration, with some one of the relishes obtainable from the regimental canteen at low prices; dinner, which takes place in the middle of the day, for which he is allowed ¾ lb. of meat and 1 lb. of bread, together with vegetables and groceries from the canteen; and tea, which is a repetition of breakfast more or less.

The regimental canteen is run on Gothenburg principles, meaning that the profit derived from the sale of pure liquor, groceries, vegetables, tobacco, etc., is applied to the advantage of the men. The canteen surplus, in fact, provides the funds for the Regimental Institute, which comprises recreation rooms, comfortably fitted and supplied with papers and a lending library. The Regimental Institute, however, must not be confounded with the semi-philanthropic clubs, known as Soldiers' Institutes, which exist in all large garrison towns. Plenty of innocent, mirthful recreation is at the soldier's disposal after working hours. Every facility is given him to indulge in football, cricket, boxing, and gymnastics; while indoors he is encouraged to hold amateur concerts and dramatic performances. After twenty-one years' service the soldier gets a pension as follows: Privates, gunners, etc., 8d. to 1s. 6d. per diem; non-commissioned officers, from 1s. 3d. to 3s. 6d. per diem; and warrant officers, from 3s. to 5s. per diem. But the soldier may rise to the rank of quartermaster or riding-master, whose pay is from 9s. to 16s. 6d. per diem, with a pension of from 8s. per diem to £200 per annum. Lastly, at the close of his military life, the Government makes every effort to find him suitable employment, a quota of situations being reserved for old soldiers in the postal service, Royal Arsenals, and Clothing and Ordnance Departments; while there is the Corps of Commissionaires, and, failing any of the foregoing, the National Association for the Employment of Reserve and Discharged Soldiers will see that he does not go berthless.

H. G. ARCHER.

Photo. Argent Archer, Kensington.

OUTPOST SIGNALLING.

THE PREPARATION OF TEA AND COFFEE.

THE tea plant, a tree allied to the camellia, grows wild in Assam, and there is a legend that it was carried to China by an Indian traveller in the sixth century B.C. Be this as it may, tea was a national beverage among the Chinese in the early centuries of this era, when mead was the national drink of the Western world, and there was a Celestial tax upon tea as far back as 793. The oldest newspaper advertisement of tea has been traced to the year 1658, when it was to be had "at the Sultaness Head, a cophee-house in Sweetings Rents, by the Royal Exchange." In 1678 the Honourable East India Company glutted the market for years by importing 4,713 lb. in one season. In the first year of the nineteenth century the consumption of tea in the United Kingdom was 23,730,150 lb.; in the first year of the twentieth the import reached the tremendous total of 298,900,200 lb., of the value of £10,686,910, and the duty paid upon that proportion of it which went into home consumption was £4,769,762.

Photo: Cassell & Co., Ltd.
BULKING TEA (CUTLER STREET WAREHOUSE).

These figures serve to show the supreme importance of the tea leaf among the industries of Britain. It is the most valuable leaf in the world, and it is estimated that it furnishes a beverage to one-half of the human race. Its manufacture provides employment for large numbers of people in Greater Britain, for of the total import already mentioned nine-tenths are grown and manufactured in India and Ceylon. The work that remains to be done in this country is comparatively small, and is limited almost wholly to the task of preparing the leaf in an attractive form for the retail buyer. Yet the highest resources of modern engineering science are brought into play, and in this, as in most industries, the division of labour has been raised to a fine art.

When tea is landed in the port of London it is conveyed to a bonded warehouse, and the first operation consists in "bulking." This, as the photograph shows, is performed by emptying the contents of a particular sort upon the warehouse floor, where the heap is turned over by stalwart labourers with the aid of a shovel. The advantage of this is that a more uniform mixture of the leaf is secured, and its exposure to the air after a long imprisonment in the hold is sometimes said to improve its appearance. The leaf is now repacked by human labour, and the weight inscribed upon the chest. A chest is set aside for sampling, and the buying houses send down their clerks to the docks with sampling orders, the tea supplied to them being given in exchange for an equal weight of tea. These samples are carefully tested for "body," colour, fragrance, and other qualities by expert tea tasters, who assess the value of each according to their own judgment. At regular intervals a sale by auction is announced to be held in Mincing Lane, to whose sale rooms the buyers resort, with their catalogues marked with the mystic signs which record the results of their tasting.

Photo: Cassell & Co., Ltd.

RENAILING TEA AFTER SAMPLING.

The tea being bought, it is delivered as required against payment of the duty, and is removed to the factory to be blended and packed.

A typical leaf twig bears about seven leaves, varying in length from a fraction of an inch to four inches. Each leaf has its own name, the terms commonly used being flowery pekoe, orange pekoe, pekoe, pekoe souchong, souchong, and congou. If the seventh and largest leaf were plucked, as it sometimes is in the case of China teas, it would be called bohea. In practice, however, the leaves are not plucked separately, but are grouped together for the purpose of drying, and are then passed through a series of sieves, which classify them once more according to size. Each grocer has his own peculiarities, according to the tastes of his customers, and long experience is required for the task of producing blends to suit the pocket and the palate of different classes of the community. The larger leaves, moreover, have to be passed through a cutting mill, in order to be reduced to a size that will mix well with the smaller sorts, and produce an agreeable impression to the eye. When, therefore, an order is received for a particular customer, a formula is prepared, with the aid of the tasting samples, and its component parts, which read upon the slip like a doctor's prescription, are taken out of stock and passed into the sifter. This is an ingenious contrivance whose most curious feature is a battery of magnets, which seize the nails, fragments of hoop iron, and other pieces of metal that have found their way into the chest through the carelessness of coolies on the plantations or of packers in the dock warehouses. With the aid of a 2 h.p. mill a deft factory girl can manipulate twenty chests, or a ton of tea, every hour.

From this machine the tea is conveyed into a rotary blender, wherein it is rotated at a slow speed, and in the course of ten minutes the blending has been performed so thoroughly that if put up into ounce packets each packet will contain a due proportion of each constituent. At this stage a pound sample is drawn for the purpose of tasting, and if the result should not reach the expectation of the expert other sorts are added and the whole reblended, until a perfect tea is produced. For delivery in bulk the mixture is now passed through a funnel and repacked in the original chests, sometimes pressed down by hand labour. A recent device, however, enables the tea

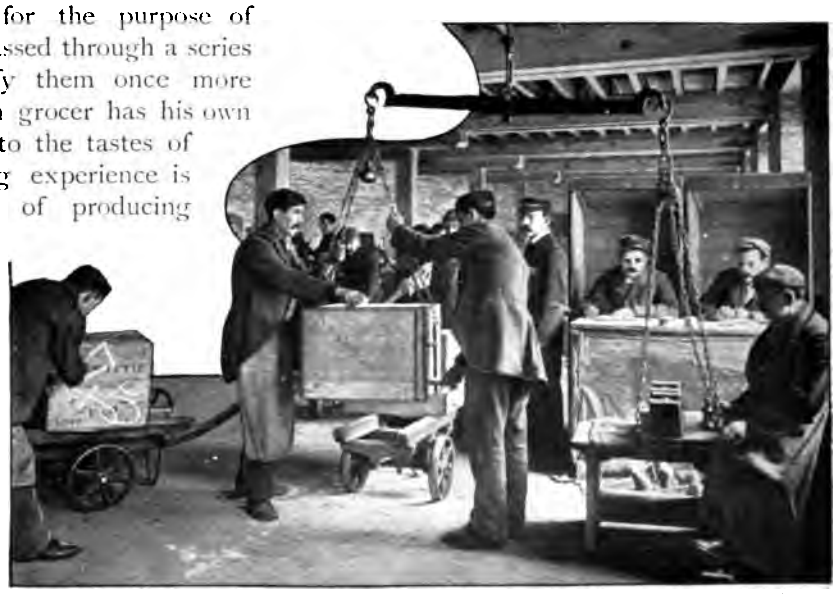


Photo: Cassell & Co., Ltd.

WEIGHING THE TEA AND INSCRIBING THE WEIGHT.

CUTTING AND MIXING MACHINE AT MESSRS. TRAVER'S WHARF, BANKSIDE, S.E.

FILLING, WEIGHING, AND PACKING TEA AT MESSRS. TRAVER'S WHARF.

(*Photos: Cassell & Co., Ltd.*)

to fall in a steady stream into the chest, which is placed upon a vibrating table that automatically shakes each layer flat, and enables the chest to be filled to its utmost capacity without being touched by the hand at any point of the operation of blending.

It is, however, the development of the packet trade which has increased the demand for labour in the tea industry in an enormous degree. An ingenious machine seizes a square of paper, pastes the edge, twists it into shape, and turns out the "bag" ready for filling. In its highest form the apparatus for weighing is actuated by electricity, and at the instant when the slow stream of tea reaches the exact weight a contact is formed which overturns the contents of the scale into the bag held ready to receive it, a process which enables the weight to be gauged to a fraction of a grain. The girl attendant passes the bag to a colleague, who inserts it into a square hole in the table, upon which a heavy weight is dropped by a lever. The ends of the packet are deftly turned down, a button is pressed, and the packet emerges from the hole ready for the labeller. The weighing and finishing of a quarter-pound packet is performed in this way at the rate of 720 per hour.

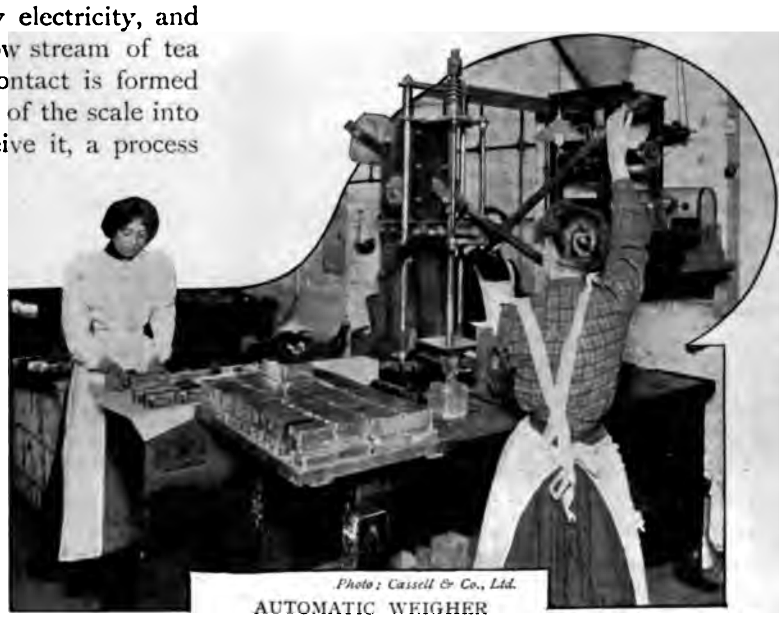


Photo: Cassell & Co., Ltd.

AUTOMATIC WEIGHER AT MESSRS. TRAVER'S WHARF.

It will thus be seen that there are no secrets in the manipulation of tea. Perfumed teas have never been popular in this country, and the artificial admixture of stimulative substances, such as kola nut, is of no commercial interest. Herb teas, which are infusions of various plants such as the dandelion, are confined to rural kitchens, and no popular tea extract has been devised, although compressed cakes have their value for tropical travel. The last annual statistics record an import of £5,000 worth of tea for the manufacture of theine, the bitter principle which gives its stimulating effect to the tea infusion; and this substance, which is a white crystal, has its uses for certain medical prescriptions. But it will be many a long day before mankind will be willing to abandon the direct use of the leaf in favour of a powder bought in the chemist's shop.

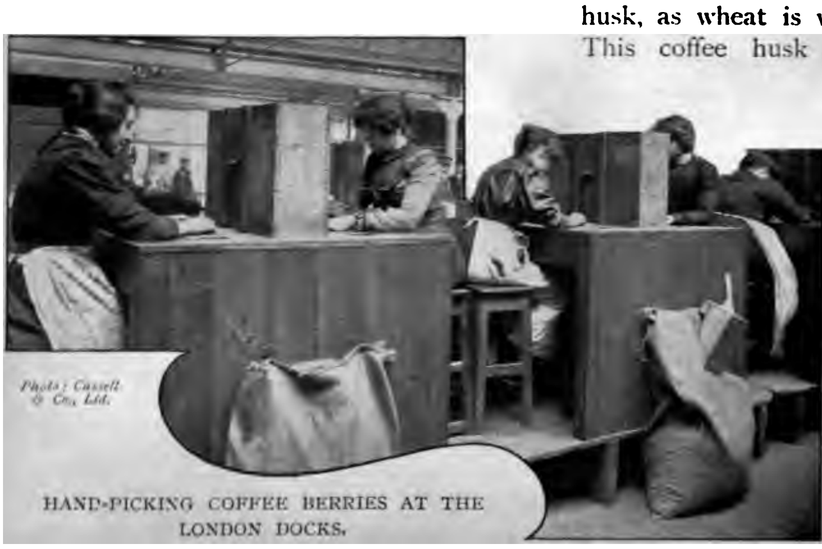
One form of the industry, which devoted itself to the preparation of spurious teas, is happily being driven out of the country by the operation of the Sale of Food and Drugs Act of 1875. Laws against the adulteration of tea were passed as early as the beginning of the Hanoverian dynasty, yet in the year 1843 there were no fewer than eight factories in London where exhausted leaves, obtained from hotels and coffee houses, were redried, faced with blacklead, and sold as genuine tea. The Chinese have attempted, from time to time, to palm off large shipments of exhausted leaves, which have been shipped to England and have gone into consumption. It is therefore a gratifying fact that during a recent year, out of nearly six hundred samples of tea analysed by the Local Government Board, only two showed traces of adulteration, and the public mind may be reassured as to the purity of the tea which is now offered for sale.

Theine, the active principle of tea, is an alkaloid which when extracted from coffee is known as caffeine. Although coffee leaves are infused for the purpose in Sumatra, the result is not very agreeable to the palate, and the stimulus derived from coffee is

obtained by an infusion of the berry. The coffee plant is a bush indigenous to Abyssinia, where its properties may have been known in very early times. But it was the Mahometans who first brought coffee drinking into general use, and it was imported into England a few years before the introduction of tea, the first public coffee house having been established in St. Michael's Alley, Cornhill, in 1652, by the Greek valet of a Turkey merchant. The drinking of coffee spread with marvellous rapidity, and, by way of comparison with the figures already cited in the case of tea, it may be added that the quantity consumed in the United Kingdom in the year 1801 was about 1,000,000 lb., whereas the total import in the first year of the following century was upwards of 109,000,000 lb., valued at £3,294,871, the amount of duty paid upon the quantity passed for home consumption being £189,783. Of the total import, however, only a fourth part was grown in Greater Britain.

HUSKING COFFEE AT THE LONDON DOCKS.

The coffee fruit resembles a cherry in appearance, and within the yellowish pulp there are two seeds, enclosed in a tough membrane called the parchment. The pulping of the fruit is usually performed upon the plantation, and a large quantity of the berry is imported in a form from which the parchment has been already removed. It is found, however, that the value of the coffee is increased by bringing it into the market with the protective parchment envelope, and the first operation, which, as with tea, is carried out in the bonded warehouse, consists in the removal of the parchment. This is known as husking, and the machine employed nips the horny substance of the skin and drags it away, exposing the two seeds to a blast of air which carries off the lighter husk, as wheat is winnowed from its chaff. This coffee husk is used as a manure, and it is upon the cleaned or husked berry that the duty is assessed.



HAND-PICKING COFFEE BERRIES AT THE LONDON DOCKS.

The next operation consists in bulking the berry and throwing it into a hopper, where it is sifted into bags, and the better sorts are laboriously picked over by girls, who are shown at work in one of our illustrations.

These sit at tables whereon a closed box with a tiny trapdoor permits a stream of berries to ooze out, at a rate which enables each to be passed under inspection. By this means inferior berries, fragments of stalk, and the like are picked out by hand. The term "berry" is applied to those seeds in which the two parts are joined together into one round seed, like a peppercorn; the more usual form is known as the "bean."

In this state coffee beans may be stored for years without injury to their qualities; indeed, for several years the essential principles of the coffee are improved by keeping, although there is a loss of weight. For this reason it is customary to pass the beans as rapidly as possible into consumption, and the destination of the bags or casks after being cleared from the Custom House is the roasting factory.

The process of roasting introduces an element of skill and judgment such as is not demanded at any stage in the preparation of tea. The object of roasting is to liberate certain gaseous elements, and to develop the aromatic virtues contained in the essential oil, besides bringing the active alkaloid principle into a form suitable for easy infusion. French coffee, which is a more or less cunning mixture of coffee with a large proportion of chicory, is, in France, usually roasted by hand over the open fire by each grocer, or even by each householder. But there is a great advantage in the regularity and uniformity of torrefaction which the experienced overseer of a steam roasting machine is able to furnish, and the bulk of "French" coffee sold in England is manipulated in the following way. Sugar is added to the coffee during the process of roasting, with the result that the berry is coated with a glistening film of black, mixed with chicory, ground, and forthwith packed in tins; it is then ready for the grocer.

Photo: Cassell & Co., Ltd.

COFFEE ROASTING AND COOLING (MESSRS. W. FIELD AND SONS, SOUTHWARK).

The older roasting apparatus, which is still to be preferred for the finest results, consists of a malleable iron cylinder revolving over a coke fire, and with wire gauze ends through which the liberated gases escape. The beans are poured into the interior of the cylinder, and by an ingenious arrangement of eccentric bearings the coffee is thrown about from side to side of the cylinder, in order to secure a thorough roasting of the whole. The result is that the bean loses in weight and increases in bulk, and the fragments of the epidermis remaining upon the surface of the bean are burnt off, leaving it smooth and clean and brown. Too great haste in the roasting, or a few degrees of heat too much, will char the

bean and spoil its flavour, so that the task of watching the roast for the slightest hint of excess of heat is an anxious one. The roaster, who is a well-paid operative, is able to follow the progress of the torrefaction by means of a sampling scoop which penetrates into the interior of the cylinder, and may be withdrawn from moment to moment without hindering the revolution of the machine. The temperature developed is about 250° C., and the roast is completed in a quarter of an hour. Each roast deals with

GRINDING COFFEE. *Photo: Cassell & Co., Ltd.*

about 1½ cwt., so that a roaster is able to turn out 4 or 5 cwt. per hour.

A quicker method adopts a gas flame, whose combustion is perfected by an air blast on the principle of the Bunsen burner. The beans rotate in the open cylinder, and as they reach the upper surface of it they fall through the flame, but it is claimed that the fall is so rapid that they are in no danger of scorching. The advantage of this quick roasting process is that it deals with double the quantity in the same space of time, and it is employed for the cheaper descriptions of coffee.

By whatever means the roasting has been performed, the next operation is that of cooling. For this purpose the beans a overturned into a tray with a woven wi bottom, through which air is forced, eith by means of a rotary fan or by a direct bla The cooling occupies a few minutes, and tl beans are then ready to be packed withou delay for distribution to the retail grocer.

The operation of grinding needs no detaile comment. It is performed by boys or gir as the case may be, and it is at this stag that the blend is made, because each sort coffee requires its own speed and temperatu in the roasting, so that it cannot be properl treated when mixed with another kin Some sorts of coffee are not self-drinkin and require an admixture of other growth to bring out their qualities in an agreeabl form. But it is very usual for a grocer t make his own mixture, according to th tastes of his constituency. The photo graphs illustrating the treatment of coffe have been specially taken for this article by his courteous permission, at Mr. William Field's steam coffee mills in Southwark.

The adulteration of coffee exercised the wit of the Legislature in the early years of George I., the substances most commonly used being roasted peas and turnips. In 1820 chicory was first introduced into the country, and after many vicissitudes it is now recognised as a proper substance for admixture with coffee, provided the label upon the package clearly states that chicory is present. The bulk of the chicory used in England is imported from Belgium, although there is a large area under chicory cultivation in Yorkshire. With practically the same rate of duty, the amount realised by the revenue from the consumption of chicory in 1901 was £56,052, or one-third of the coffee duty. Chicory is kiln-dried and passed through a machine which cuts it into dice; it is afterwards roasted and ground in the same way as coffee. It is found that stone mills are better than steel ones for grinding mixtures of coffee and chicory, because the bruising of the coffee bean caused by the stone develops an aroma which is absorbed by the chicory grains, with the result that there is a greater uniformity of taste and appearance when this process is employed.

E. G. HARMER.

CARPET MANUFACTURE.

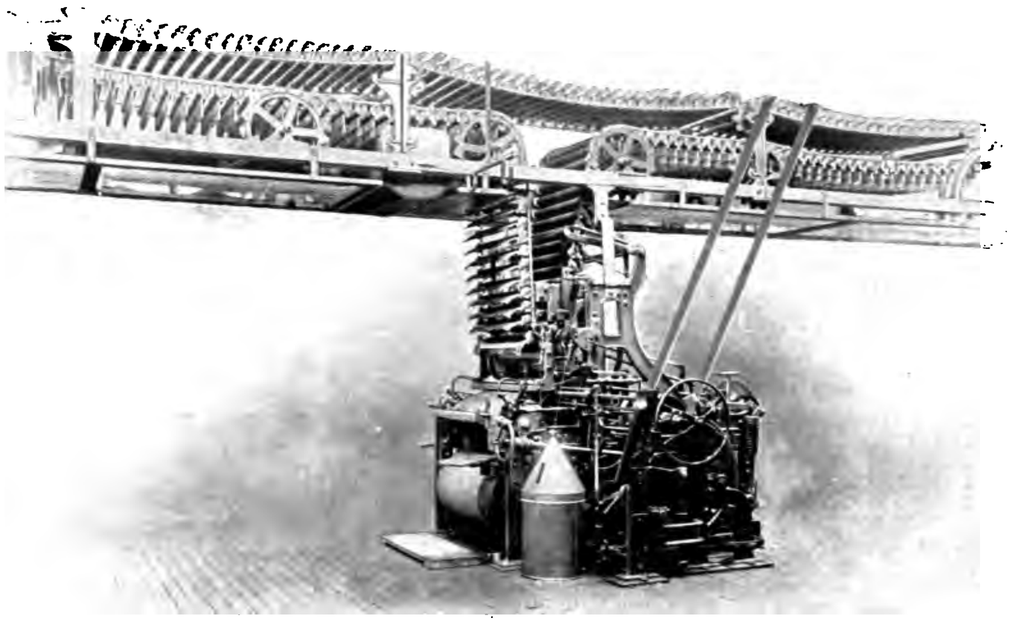
MACHINE industry has stimulated variation in the carpet trade during the past half-century, and it would be rash to state a positive limit to the kinds of carpet produced in Great Britain. Only six distinct kinds of carpet, however, are largely produced. These are Brussels and Wilton, Axminster, patent Axminster, Kidderminster, tapestry, and felted carpets.

With the exception of the Kidderminster and felted varieties, all carpets are woven of wool and linen or jute. The mode of preparing these materials for weaving is, up to a certain point, precisely the same for all. The wool is sorted, scoured, spun, and reeled into hanks. Similarly the linen or jute foundation of the carpet is spun into yarn and reeled on to large bobbins. After this the treatment of the wool for the different varieties of carpet is so diverse that each process must be described separately. We can go further, however, in the general treatment of the jute. The bobbins are placed in high creels or frames, one on each side of a bare beam. From each of the bobbins a thread is led round this beam, and then by a mechanical movement all the yarn is wound on to the beam. Next, this beam of yarn, or warp as it is called, goes into the dressing room. The warped beam is laid on the end of a long vat filled with boiling stuff of a starchy nature, in which cylinders roll and churn. Through this vat the linen warp is led, and wound on to a beam at the other side. Again the warp is unwound, this time to pass through heated cylinders, and returns to the weaving beam grey and glossy. Part of the linen yarn is reserved for another purpose. The dressed yarn is hanked, and then sent to the yarn-winding machines. Stretched round a wooden frame extended horizontally along the back of the long winding frame, the threads of the hanks are run through little eyelets and on to a long spool that twirls with the motion of the machine. Round go the swifts, reeling off the thread, and the while the spools are filled. Linen warp and linen weft are now prepared, and the process is the same for all kinds of tufted, looped, and pile carpets. At this point difference begins.

For the sake of clearness we will first describe one process at once, viz. the manufacture of Brussels carpets.

BRUSSELS CARPET:
PERFORATING THE CARDS FROM THE DESIGN PREPARATORY TO THE CARDS BEING LACED TOGETHER IN ROTATION FOR THE JACQUARD MACHINE (MESSRS. RICHARD SMITH AND SONS, KIDDERMINSTER).

Carpet manufacturers make their own designs. The designing room is usually a well-lighted, spacious apartment, closely resembling an art school, with easels and drawing desks disposed all over the room. Leading designers work out their ideas with the aid of models: one here is studying the graceful contour of an antique vase; another has in his left hand a bunch of fresh flowers, while with his right he tries to reproduce their beauty. Some are working with charcoal, others paint from a full palette. From the



CROMPTON AXMINSTER LOOM (MESSRS. RICHARD SMITH AND SONS, KIDDERMINSTER).
THIS LOOM IS CAPABLE OF WEAVING THE FINEST AXMINSTER CLOTH KNOWN AND OF PRODUCING UP TO FORTY YARDS PER DAY AND ANY NUMBER OF COLOUR SHADES.

chief designers the sketches are taken to the copyists, who paint them on to pointed paper for the use of the colourists and weavers. This brings to view an important limitation of the carpet-maker's art. He works with a thick thread, and no line of colour, no diversity of shade, can be smaller than the square of the thickness of the worsted. The pointed paper is ruled in squares equal in size to the thickness of the doubled thread.

While the designs have been prepared the wool has been undergoing treatment. From the stores on the ground floor the worsted yarn, yellowish and oily, is taken to the scouring room and plunged through a series of baths ranged in long succession—first a bath of alkaline solution, next soapsuds, next clear cold water. Swished round and round by long forks, the wool is borne automatically from one bath to the other, then passed between two heavy press rollers. Dried in steam-heated stoves, the yarn is prepared for the dyer, who has already mixed the dye in the troughs. He hangs the hanks on the churning frames in the troughs, and leaves them till the worsted is permeated with the colour. Again the yarn is dried, and next it goes to the winders, whose machines are very similar to those we saw winding the spools for the weavers' shuttles. Wound on to spools, the yarn is stored in the colourists' department. Hither comes the colourist with the design in his hand, and he carefully selects the colours suited to the pattern from his stock of yarns.

The yarns selected are sent to the frame-setting room. Girls receive the spools, and lay them thread by thread across long frames, stretching the yarns from end to end of the frames. Every colour appearing in the Brussels carpet must be represented by at least one thread the full length of the warp, for the whole carpet is of one thickness, and it is the warp that gives it body. The threads of the warp appearing on the surface were formerly selected by a draw-boy, taught to pull certain strings looped round each thread; but the Jacquard apparatus has superseded the draw-boy, and given to the operation an accuracy and facility very wonderful. By a special process the Jacquard cards are prepared for their function, being perforated in curious fashion. The frames are laid behind the loom—two frames, four frames, or six frames, according to the size and weight of carpet to be woven. From above the loom depend many wires, and attached to them are loops which are passed round the threads on the frames. The cards are hung beside the upper ends of the wires. Linen warp, beam, and

shuttle are in their places. Away goes the loom. Driven by quick strokes from the handle, the shuttle flies to and fro, the linen warp parts solidly to let the shuttle knot its threads; but only a few threads of the worsted lift. This is the act of the cards above. Only those wires the ends of which enter a perforation in the card can act, for the others are held out of gear. Every successive card selects the requisite threads of the warp and calls them to the surface. Between linen and worsted warps long steel wires are inserted, looping up the worsted brought to the surface. The shuttle goes forward, carrying with it a wire to loop up the coming warp, and as it runs back again it withdraws a wire that has already served. So the weaving of the carpet goes on, the pattern growing with every beat of the slay, every double course of the binding shuttle. When woven, the carpets are taken to the inspectors, the darners, and the finishers, thence to the warehouse or despatch department.

The first English town in which Brussels carpets were made was Wilton. It is said that the weavers there were taught by a Frenchman smuggled over the Channel in a cask by an Earl of Pembroke, who wished to do his neighbours a good turn. Wilton weavers did not receive the Brussels carpet unintelligently. Without delay they sought to improve the fabric. One device the Wilton men invented has given birth to a new form of Brussels, which is now known as the Wilton carpet. The Brussels carpet surface is formed of tiny loops, and by the simple expedient of fixing a little cutting blade at one end of the looping wires, that as they are withdrawn cuts the loops and leaves a fine velvet pile, the Wilton weavers made a carpet soft and beautiful. Wilton and Brussels carpets are similar in every other respect.

Though possessed of the Brussels and Wilton carpets, British buyers turned longing eyes on the carpets of the Orient. Encouraged by the Society of Arts, the Axminster weavers began the manufacture of Persian carpets, and some time after Wilton also took up the trade. Persian carpets are built slowly

THE "SETTING" DEPARTMENT OF THE CROMPTON AXMINSTER CARPET PLANT (RICHARD SMITH AND SONS).

together, tuft by tuft of coloured wool knotted over on to the linen warp, the thread of weft securing each line of tufts as completed. But the trade has never grown to any dimensions, because the market is limited for articles so costly, and the Axminster might have been classed among the industrial pro-
icts too exceptional for notice had it not
en the parent of one of the most extensive
rpet industries in the world. This is the
tent Axminster carpet manufacture. About
;8 a Paisley shawl manufacturer, named
nes Templeton, bethought him that the
nille fringes he made for his shawls might
y well serve the same purpose as the
nfully tied tufts of the Axminster carpet.
1839 Templeton devised and patented a
nille loom that produced a continuous
fringe of wool bound together by a linen
e, which when laid row on row perfectly
embled the Axminster fabric. Satisfied
h his experiment, Mr. Templeton removed
Glasgow and there founded a large factory.

The weft of the patent Axminster carpet is chenille fringe which must first be woven. The process is very detailed and elaborate. From beginning to end of the long process the design of the carpet must be kept in view. Having been scoured and dyed, the yarns are formed into hanks and wound on to cops for use in the chenille weaver's shuttle. As many as forty different shades of colour, in as many different shuttles, may be required for one design. The chenille loom has a linen warp, but curiously heddled, so as to leave a wide space between each pair of warp threads. Instead of producing a cloth, the chenille weavers make a series of worsted strips divided by linen bands. When taken off the loom the web is sent to cutting machines that neatly halve each strip and form long cords of chenille fringe. Here, with the colours in order appointed, is the weft of the carpet. In the carpet-weaving shed the looms are of great size, some measuring thirty feet broad. On a linen warp the chenille cord is carefully laid, the shuttle is sent to and fro, the powerful slay coming forward thud-thud. So, thread by thread, the great carpet is woven.

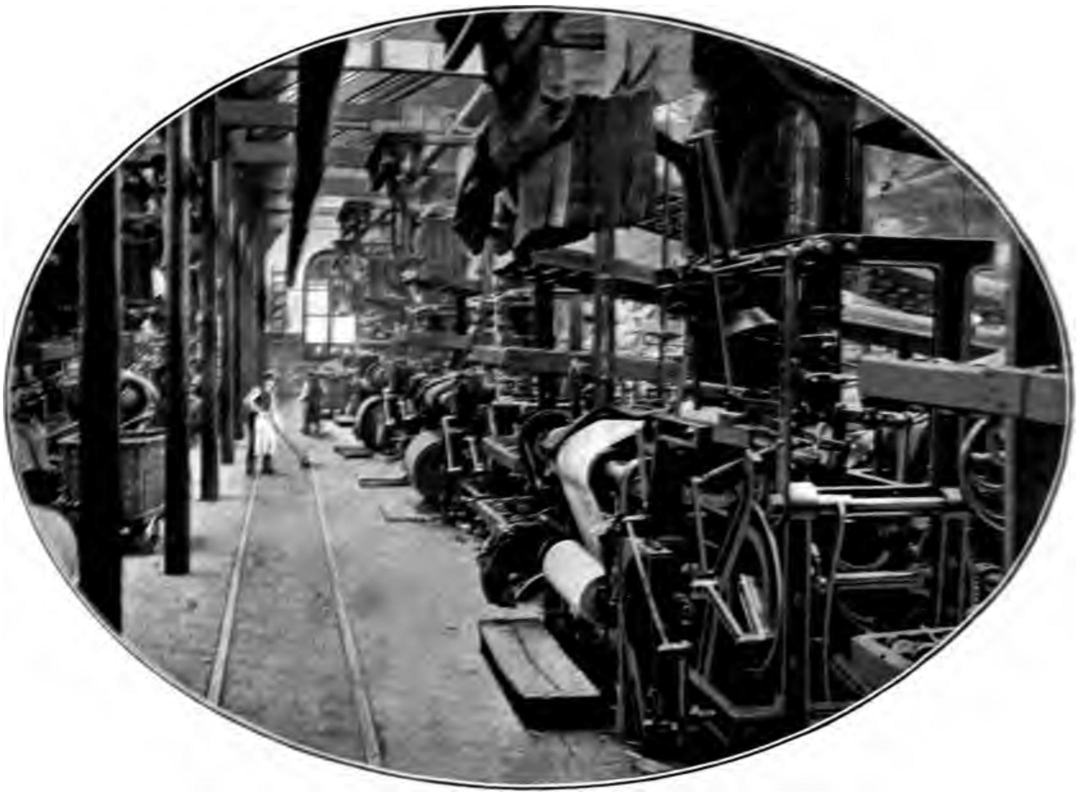
Perhaps the most perfect invention for producing Axminster carpets is the loom originally designed by George Crompton, Worcester, Mass., U.S.A., in 1881, and finally perfected, after a long series of experiments costing about £100,000, by the well-known carpet-making firm of Messrs. Richard Smith and Sons, Kidderminster, in 1894. The Crompton Axminster loom combines without difficulty as many shades of colour as the artistic designer may require, and produces at the rate of forty yards per day.

The finishing of these carpets is rather more elaborate than that required by the Brussels carpet. Passed through a cylindrical cutting machine to clear away protruding threads, calendered, and carefully finished, these machine-made reproductions of the Oriental carpets are then ready for the market.

Kidderminster was a famous centre of woollen broadcloth manufacture when carpet weaving was introduced into this country. The weavers of the town quickly picked up the new craft, and about 1735 were said to excel as much in carpet weaving as they had formerly done in the manufacture of broadcloth. At first they wove only Brussels carpets; but later the Kidderminster genius brought forth a carpet which was at once cloth and carpet. Taking the hint of the double warp from the Brussels loom, the Kidderminster weavers devised a double web, and formed from it a thick all-wool carpet, patterned on both sides. Mr. Thomas Morton, a Kilmarnock manufacturer, added a warp to the thickness of the Kidderminster carpet, and this became known as "Scotch three-ply Kidderminster." Later the name was shortened and applied to all carpets of the kind, giving thus a double and interchangeable name to the article.

Kidderminster carpets are formed by worsted warp and wool weft. Worsted, it must be understood, is a woollen yarn which has been twilled in the spinning, while wool weft is spun as evenly as possible, the fibres being wrought together so that the serrated edges of the wool may interlock. The worsted thread is smooth but firm; the wool thread is rough and soft. Kidderminster weavers had long known all the se
woollen yarn manufacture, and the
gave them a fresh mode of working it.
if composed of the same wool the
weft yarn of the carpet

WORKING THE CROMPTON AXMINSTER LOOM (MESSRS. RICHARD SMITH AND SONS, KIDDERMINSTER).



SHED WITH BRUSSELS LOOMS (MESSRS. TEMPLETON AND CO., GLASGOW).

company. Scoured, sorted, opened out, lapped and carded, the warp and weft may run together; but the carded slivers of the worsted warp go into the combing machine, and the wool slivers are taken away to the drawing frames. Through a series of cylindrical combers the woolly slive destined for worsted warp is passed, and then on to the long series of spinning frames, drawers, slubbers, roving frames, and spinning mules, arriving in shape of yarn hanks for the scourer and dyer. Passing through their hands the worsted and wool weft suffer alike, and issue coloured according to design. The weft goes to the reelers to be wound straight on to the cops the weaver fills into his shuttle, while the warp must undergo another winding on to bobbins, and thence pass on to the warping flat, there to be wound in serried rows, giving up the thread to a long beam. At the weaver's loom weft and warp again meet to combine in one fabric. In this loom the experience of the weaver who has woven both cloth and carpet is curiously blended. The double loom, the Jacquard apparatus directing the two-sided pattern, the tiered shuttle slays —all suggest the weaving of some mighty giant's clothes. The patterns of Kidderminster and Scotch carpets are varied and artistic, the Jacquard apparatus giving the designer as much scope as he can reasonably desire.

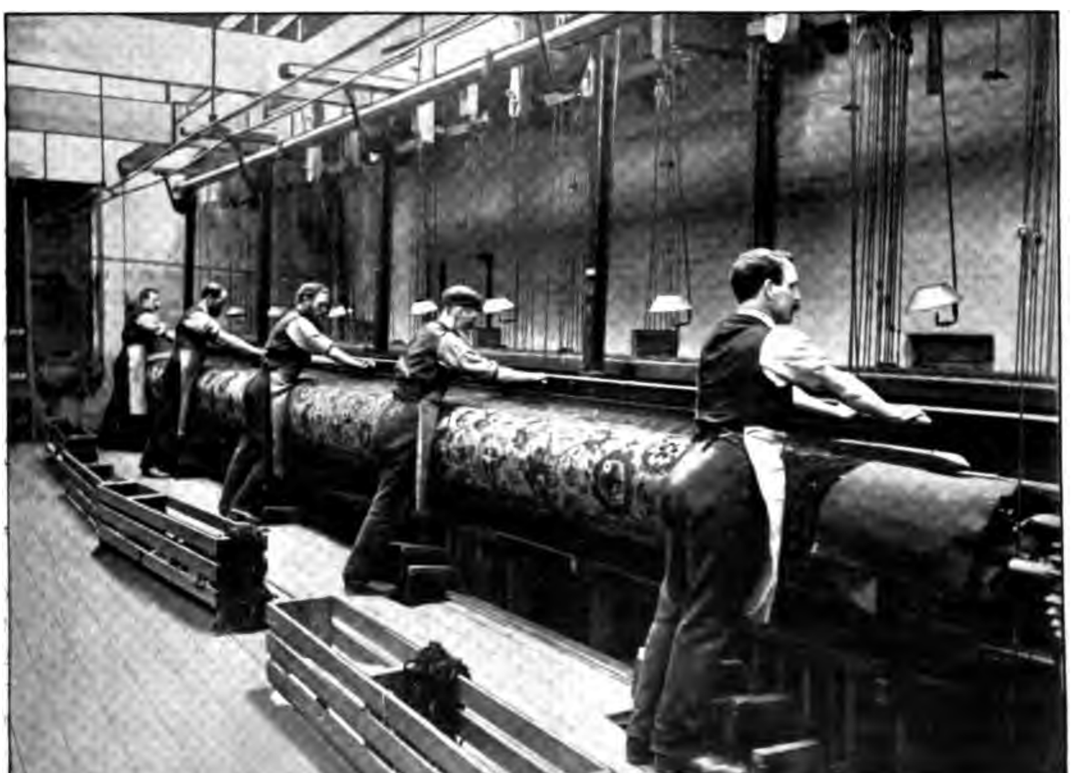
The tapestry carpet is of British origin, being invented by Mr. Richard Whytock, of Edinburgh, about the year 1840. Many efforts had been made to produce a light kind of Brussels carpet, but the results were unsatisfactory. Most of the inventors who failed attempted modifications of the Brussels carpet loom, but Whytock boldly discarded the Brussels method. In Brussels carpets every colour in the pattern is represented by a thread running the whole length of the warp, the pattern being formed by the weaving. Mr. Whytock reversed the process, imprinted the pattern on the warp, allowing for the area taken up by looping up of the warp threads, and thus, with a single layer of wool on a linen foundation, made a light and artistic form of Brussels carpet.

After the designing, the first important department in a tapestry carpet factory is the

printing. No dyeing takes place in this factory. Having been sorted and scoured, and spun into hanks, the wool is wound on to spools for the yarn printer. Set together on a board below the huge circular printing drum, the yarn bobbins slowly and carefully give out their yarn to the drum, covering it over with white threads. Round the printing cylinder is a copper rim, all toothed and numbered, while the frame holding it has a corresponding rim. Below the drum lies the colour box, and within it a broad-sided disc revolves, at each revolution dipping itself through the colour. Colour box and disc are easily changeable. Suppose the colour is yellow and on the pattern yellow is numbered 50, the printer nicks the point 50 into the side catch and sends round the drum. The little colour disc below is busy running backward and forward across the drum, and when the machine stops yellow bars of colour mark the yarn wound on the drum. These acts are repeated till the drum has been changed from white to a rainbow-like cylinder. Immersed in bran to fix the colour, washed with clear cold water, dried in steam-heated stoves, and wound on to spools, the yarn is made ready for the warp setters. This is the critical act of the tapestry process. At one end of the long setting board is the bobbin frame, while at the other is the weaver's beam, and the yarn has to be transferred from bobbins to beam.

Carefully unwinding the yarn from the bobbin, the setter lays them together, forming the warp into the pattern. When she has got all the threads properly placed the setter clamps that part firmly, draws it gently on to the weaving beam, and then resumes the setting process, thus making the warp of a large carpet. When the warp is ready it is taken to the weaving shed, and there joins the previously prepared linen warp and weft. Like the Brussels carpet, the tapestry carpet surface is formed of little loops. Here also we see at the front of the loom the long steel wires thrust between the linen and worsted warps with the forward stroke of the shuttle, the shuttle in its backward flight withdrawing a wire from the loops already fixed.

William S. Murphy.



LARGE HAND LOOM FOR AXMINSTER CARPETS (MESSRS. TEMPLETON AND CO., GLASGOW).

THE CAB INDUSTRY.

ALMOST the first thing that strikes one when studying the cab industry is the great proportion of masters to be found amongst its members. The joint-stock principle is not entirely absent. Considering, however, the important place which it occupies generally in modern commercial life, it is noteworthy that the limited liability company is very far from being a common feature of the cab trade. In London the cab traffic. The London Police have special staff at Scotland Yard for dealin with matters relating to the trade. A applicant for a driver's licence is there sub mitted to a searching examination in th topography of the metropolis. Seeing tha

Photo: Cassell & Co., Ltd.

BUILDING CABS AT MESSRS. FORDER AND CO.'S WORKS, WOLVERHAMPTON.

number of men licensed by the Police authorities to drive hackney carriages is practically fifteen thousand. Of this number it is computed that between two and three thousand own a single cab and drive it themselves. The greater portion of the cab trade, however, is in the hands of small owners, working from five to ten cabs and from seven to fifteen horses. A small number of London firms own over a hundred cabs; but, unlike other trades, there is no sign whatever of the wealthy capitalist absorbing his poorer competitor.

In all the leading towns of Great Britain and of the Continent the Police are endowed with drastic powers for the regulation of the in London there are about thirty thousand streets, the examiner finds little difficulty in puzzling candidates. The questions are, however, always restricted to the locality of places of some importance. Those who qualify receive a badge, for which an annual fee of 5s. has to be paid to the Police, the yearly revenue from this source amounting to between three and four thousand pounds. No hackney carriage is permitted to ply for hire on the streets of London until it has been certified as suitable for the purpose by the police inspector specially employed upon this duty. The standard for hackney carriages demands not only soundness of build and material, but likewise some

approach to elegance. If the cab passes the test, a plate is affixed by the Police, bearing a number surmounted by the Royal arms. A sum of £2 a year is paid for this plate, and a further 15s. has to be disbursed for wheel duty. As about eleven thousand hackney carriages are in constant use, it follows that the plate and wheel tax and the drivers' licences drain about £35,000 a year out of the pockets of the London trade. In the provinces merely a few shillings are paid for the plate, while the wheel tax does not apply to Ireland at all. The Dublin and Belfast cab trade escape, therefore, altogether an impost which is paid with great reluctance by the English proprietors, their view being that Parliament intended to exempt carriages kept for profit.

Photo: Cassell & Co., Ltd.

TESTING CAB DRIVERS.

From the figures just given it will be noticed that the number of cabs regularly plying for hire in the capital is much lower than the number of drivers. While there are fifteen thousand licensed drivers, there are only seven thousand hansoms and four thousand four-wheelers. The excess of cabmen over vehicles is necessary because a fair proportion of men find other occupations at certain seasons. Moreover, the hardships of the life entail a high rate of sickness, so that there is a constant demand for substitutes. A number of owners hold licences though they

Photo: Cassell & Co., Ltd.

CAB WASHERS AT WORK (THE LONDON IMPROVED CAB COMPANY'S DEPÔT).

very seldom drive. [illegible] allowance has to be made for a percentage of drivers whose temperament [illegible] harmonise with unremitting attention to duty. [illegible] that [illegible] many [illegible] all the [illegible] with cabmen is [illegible] that [illegible] London cab [illegible] horses [illegible] horses [illegible] generally deemed sufficient [illegible]. It is a striking fact full of meaning for the economist that the extension of railways and the multiplication of omnibuses and trams has [illegible] the cab trade. [illegible] London is not [illegible], and their quality is on the whole improving rather than deteriorating, a [illegible] which bears but one interpretation.

The largest proprietor of [illegible] in the United Kingdom is the London Improved Cab Company, which is a joint-stock concern giving employment to eight hundred men and more than a thousand horses. None of its rivals attempt business on so comprehensive a scale. At its premises in Pakenham Street it builds its own vehicles and equips them down to the smallest detail. It makes its own harness and lamps, and shoes its own horses. Its really splendid stable accommodation includes a hospital, which is attended by the company's own veterinary surgeon. Even the india-rubber tyres for the wheels and the brass mounting for the harness are made by the company's workmen. The London Improved Cab Company's place being so entirely self-contained, it affords an excellent idea in miniature of the industrial importance of the cab industry and the numerous trades that derive some degree of sustenance from it. The layman has but a vague notion of the serious part played by the coach-painter in the production of a hansom. When the "body-maker" has completed the shell, layer after layer of paint is laid on until about twenty coats have been applied. Besides the highly skilled artisans employed in the trade, and the large number for whom it provides clerical occupation,

Photo: Cassell & Co., Ltd.

"CHANGING HORSES" (LONDON IMPROVED CAB COMPANY'S DEPÔT).

there are in London between three and four thousand horsekeepers and yardmen dependent upon the cab owner, as well as some hundreds of men and women who make a livelihood as lamp-cleaners. The London Improved Cab Company and all the large proprietors have their own granaries; but the small owner is obliged to buy his supply of corn from day to day from the corn chandler, who reaps a handsome profit. Practically all the forage consumed by the London cab-horse is imported from Russia, which means an annual loss to agriculture of a considerable sum. Curiously enough, though London is the head-quarters of the hansom as a street carriage, Wolverhampton is the head-quarters of the building industry. Many of the best-appointed hansoms one sees in the streets of the metropolis, as well as in the provinces, have been built there. But at the same time it is necessary to add that almost all the leading cab proprietors in London build vehicles for their private business, and that they can when necessary produce specimens of the very highest workmanship. At first sight there is not much connection between the business of driving a hansom and that of a *restaurateur*. A large number of drivers, however, are engaged superintending the cabmen's shelters which are found in all parts of London. These positions are given to men specially selected by the authorities of the Cabmen's Shelter Fund. Light refreshments are provided, and the caterer appropriates all returns, merely paying a small rental to the fund, in return for which the shelter is kept in repair and otherwise maintained in proper working order.

The value of a cab varies from £70 to £90. The horse is worth on an average £30. A set of harness costs anything from £5 to £10. The sum invested in the London cab trade falls little short of a million sterling. What the cabman himself earns, and the consequent turnover in the trade, it is more difficult to determine, owing to the conditions under which the industry is conducted. In London cabdrivers never receive a weekly wage. On the contrary, the proprietor farms out his stock to the driver, receiving in return an average rent of about twelve shillings a day for a hansom and a few shillings less for a four-wheeler, the precise sum fluctuating according to the season. The driver puts the balance of his earnings in his own pocket — that is when there is a balance. The best returns are as a rule obtained in the West-End, especially in the height of the London season. The average cabman professes to be well content if at the close of the day of fourteen or sixteen hours he has a surplus of 5s. or 6s. for his private purse. In the provinces a totally different order of things prevails. There it is usual for the proprietors to pay the driver a weekly wage, varying from 14s. to £1 a week. The driver then hands over to his employer all receipts, taking care, however, to deduct for himself anything paid him over and above the legal fare. The

Photo: Cassell & Co., Ltd.

CLEANING LAMPS (LONDON IMPROVED CAB COMPANY'S DEPÔT).

arrangement is not a satisfactory one, inasmuch as there is no check upon the employee's honesty, save the master's general knowledge of the state of trade. The objections to this system could be overcome by the introduction of the taxameter. This is an instrument in use in Berlin, Hamburg, Bremen, Basle, and other Continental towns. It registers the distance traversed, and the amount to be paid by the passenger. It also indicates the idleness of the driver to the master when the driver's work is finished. The conditions under which the trade is conducted in London render its use unnecessary so far as the masters are concerned. It would, however, be a convenience to the public, though the drivers would probably view its advent with regret.

There is no limit to the number of hackney carriages that may be licensed in the metropolitan area. But in Southampton, Blackpool, Scarborough, Preston, Wolverhampton, Leeds, and several other places the number is strictly limited. The London cabman has long desired a change in this direction, in the hope of benefiting by the diminished competition. The landau as a hackney carriage is very popular in Edinburgh and Glasgow, and while the victoria is for hire in nearly all the English provincial towns, in London it is

A FAMILIAR STREET SCENE.

practically unknown. Some years ago the experiment was tried of placing them on the cab-ranks, but the share of patronage accorded them was so insignificant that they were very soon withdrawn. The "outside car" is peculiar to Ireland. There is, however, a world of difference between the well-appointed vehicle, with pneumatic tyres and plated fittings, which may be hired at any of the principal cab-ranks in Dublin and the jaunting-car found in remote country districts. At Irish seaside resorts, just as in similar places throughout the United Kingdom, there are always landaus and victorias on hire for the convenience of visitors.

Photo: Valentine & Co., Ltd.

A CABMAN'S SHELTER.

The railway stations in London, and in most of the leading provincial towns, are closed against the general body of cab-drivers. Waterloo is, however, exceptional, for it is open to all comers on payment of an entrance fee of a penny. The men who attend the railway stations are known as "privileged drivers." Rent varies from 2s. to 3s. a week for admission to a station, the Great Central, Paddington, and the London, Brighton and South Coast being the most expensive. Formerly a cab could only work at one station; but an interchangeable system now prevails, under which a vehicle which is housed at one station is free to all.

One of the most pleasing discoveries which the special study of any trade reveals is the number of niches it provides for humble hangers-on. It is impossible to state how many hundred men in the metropolis, and how many thousands in the kingdom, live by loitering round cab-ranks, theatres, churches, shops, museums, and such places, ready to stand at a horse's head should their services be required. Their reward is a copper or two. A halfpenny one way or the other indicates whether the driver has been prospering or otherwise. At most of the important cab-ranks there is generally one man employed to look after the horses, while the drivers stretch their limbs or snatch a meal in the interval of waiting for a fare. Mats and nose-bags seem trifles to the ordinary hansom passenger; but their manufacture helps to fill many a homely larder. The making of nose-bags is one of the arts often acquired by the blind. The work demands no great skill, and if the profit is small it nevertheless means a great deal to the poor creatures whose earning power is so heavily handicapped by affliction. A curious phase of the trade exists only in Bloomsbury. There the stables, having been originally constructed for the convenience of private individuals, have living apartments overhead. These are frequently occupied by families unconnected with the cab trade, and the housewife occasionally receives a small rent for minding the cabmen's "tools." This rent is hardly a fixed quantity, so much depends on the state of business. When the cabman is prospering he is no niggard. At one time omnibuses and trams were the nightmare of his life, and dark days were prophesied. Then electric railways appeared on the scene to try his nerves. The advent of the motor-car has, however, introduced a serious cause for apprehension into the horizon of those interested in the hackney car industry. It is for neither individuals nor combinations to check revolutions in modes of transit; but few will look forward with anything but regret to the day when London shall no more know its "gondolas" and its "gondoliers."

P. F. WILLIAM RYAN.

Photo: Cassell & Co., Ltd.

ON THE RANK.

SUBSIDENCE OF A HOUSE AT NORTHWICH.

WITH THE SALT WORKERS IN A CHESHIRE MINE.

"A PINCH of salt" seems a trivial commodity, yet common salt, composed of sodium and chlorine, is indispensable; and the use of it has been responsible for romance, superstition, and effort in many lands. Salt is mentioned in the Scriptures as an article of food and as a token of good faith. The Arab will safeguard foe if he has "eaten of his salt"; the saying "true to his salt" indicates that the Sepoy is loyal; and the Turk, though keen at a bargain, may be trusted if he has eaten bread and salt over a business transaction.

Salt is necessary to the vitality of vegetation, and to the existence of the animal kingdom; and Nature, fortunately, gives an inexhaustible supply of it in rock salt, earth salt, brine spring, salt lake, sea, and desert. Britain, rich in mineral wealth, has a great store of salt, both in rock and brine, but Cheshire and Worcestershire are the chief salt-producing areas. Originally salt was obtained entirely from brine, and was of so much account that the Roman soldiery who invaded England were partially paid their wages in salt, a custom that created the word *salarium*, familiar now to every industrious person in the shape of "salary."

The salt manufacturers have located works in and about Northwich, Middlewich, Winsford, Sandbach, and Droitwich; but Northwich is perhaps the most interesting centre of the salt industry. The perpetual pumping of brine is followed by a slow but scarcely perilous settling of the land. The foundations of houses and shops give, and habitations and business places lurching forward or leaning backward or aside have rather a convivial look, as if the saline in the atmosphere had induced a thirst that only inebriation could assuage. Northwich, notwithstanding, is a perfectly safe place to live in. The buildings are not dangerous in their rollicking.

There are extraordinary stories of strange occurrences, of narrow escapes, and of actual engulfment when ground and buildings have collapsed; but the majority of these legends may appropriately be taken *cum grano salis*; loss of life is rare, either from subsidence or rock salt mining. The writer was, however, shown a two-stalled stable standing all awry on sunken ground, and told that a horse haltered for the night in one stall had disappeared the next morning. The animal had not broken away, the ground had given beneath its feet; it had been swallowed up either in a brine pit or an old shaft.

Where the chief industry changes the contour of the ground a special style of architecture and special use of brick and

timber is necessary. The building is primarily a strong wooden framework, and the brick-work is filled in; consequently, in case of subsidence, it is possible by means of a hydraulic jack to "lift" the house or shop, to tilt it this way or that, and make good the sunken ground beneath it, and, as it were, to place it steadily on its legs again. The damage to and the repair of buildings is covered by a fund at the disposal of the Salt Compensation Board, the money being raised by a tax on the brine pit proprietors. The levy does not exceed threepence per 1,000 gallons pumped, and inasmuch as 1,000 gallons of brine yields one ton of salt, the compensation burden is not particularly heavy.

The making of salt from brine is an old industry at Northwich. The salt museum contains specimens of rock, common, table, cheese, and fishery salt from India, America, Europe, and Cheshire, and in it are also treasured two salt pans and a black wooden brine trough or cistern, which were in use before the seventeenth century. The salt was formerly evaporated in a "wych-house," and nearly all the towns engaged in salt production retain their name termination of "wich." There has been little change in the brine industry for many centuries. The inventor has sought to economise labour by a trial of automatic brine pans, but the old method is generally continued, that of the evaporation by intense heat of the water from the brine pit or spring. Hand pumps, water wheels, horse power, and windmills have been utilised in pumping, but steam is the almost universal agent, and the shafts through which the brine is raised are, as in the rock-salt mining, cased with iron cylinders to keep the pit free from surface water.

The brine after pumping is run into reservoirs, from which it flows by gravitation into the evaporating pans. In the Witton works at Northwich good quality coal slack is used for firing the furnaces that range beneath the vast salt pans. The wich house, or salt-making shed, is almost tropical with heat, and thick with ascending steam and vapour; but through the haze you can see the pans, brine-filled, their contents of salt and water boiling and bubbling in a ferment, the salt gradually settling to the bottom of the pans in masses white as snow. The highest temperature and the least time in the pan produces the smallest grained or the finest salt, and the lesser heat and the longest period in the pan gives the largest grained or the coarsest salt. The finest is drawn frequently, otherwise the crystals would

BRINE RUNNING INTO CISTERN.

become too large, and the salt layer at the pan bottom would act as a non-conductor of heat to the brine, and prevent it from boiling.

When the household, fishery, or other salt is ready for drawing, the waller, as he is called, rakes it to the pan side, and with his skimmer—or sieve-like spade—shovels the salt upon the platform or hurdle that fringes the pan. The brine drains through the pierced spade, and the salt, heaped on the hurdle, is taken to the storehouse, or placed in moulds and dried in the familiar shape of the lump of salt that one sees carted about for sale in every city.

"What wages do the salt boilers get?" is met with the rather indefinite reply, "As much as they can earn."

SALT PAN.

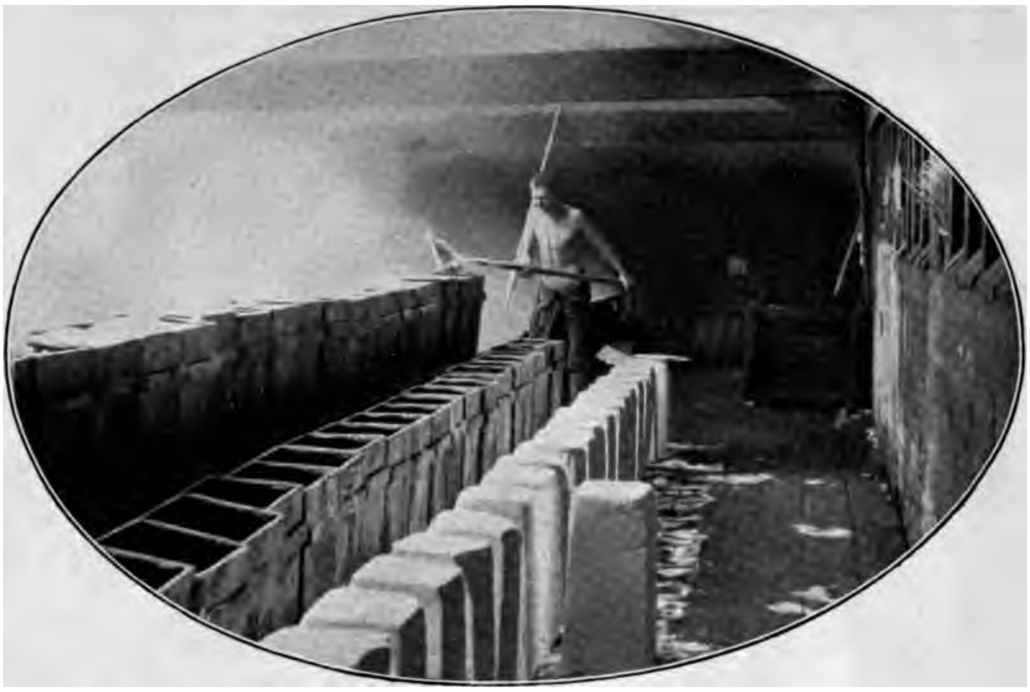
DRAWING SALT OUT OF PAN.

Really they are better paid than the rock-salt miners, averaging from thirty to thirty-five shillings per week; and they deserve what they receive, considering the intense heat in which they labour.

In olden time the salters of Scotland, making salt from sea-water, were bound by law, on entering the works, to perpetual service; and even in the case of the sale or alienation of the ground on which the works were situated the right of their labour, without any express grant, passed to the purchaser. But the salt miners are in no such servitude. Though their toil is hard, they are paid a fair price for their work, at the rate of four-and-sixpence for the eight-hours day. They labour in better conditions than the coal miner, and are in less peril, for the air is pure in the mine, and there is no risk from fall of brine or from gaseous explosion.

Branching off the main street and going up the slope past the corrugated iron mission-room, you are at the mouth of the Baron's Quay Mine. The roof of the engine-house covers the mine shaft, or rather the two shafts used for drawing. The engine man, satisfied with your introduction, places his mouth over the near shaft, and with the lungs of Thor, the god of thunder, shouts "G-e-o-r-g-e!" His voice, stentorian, echoes all around you and rings far away down the shaft, for some time in vain; but eventually George, or his substitute, telephones with two or three clicks, as of his knife blade on the suspended chain, and you prepare to go below.

The rock salt is hauled out of the mine in buckets, similar in shape to the domestic article, but much larger, and particularly much deeper. There is a special bucket, however, for people who have the privilege of exploration. It is nearly five feet high, padded, and has a door through which you gain admission to the perpendicular vehicle. You enter it as it swings at the mouth of the shaft, and are reminded of Diogenes in his tub! You are warned to crouch, to dip your shoulders, to bend your head; and, the signal given, away you go into the darkness, with the



MAKING SALT SQUARES.

toecap of a miner's boot sticking into your back, for standing on the top of the bucket, and grasping the chain that holds your life in its links, is a miner travelling astride. You seem to be dropping through chaos; but you are really descending the shaft, which is iron cylindered to prevent water from entering the mine. A glimmer of light, casting weird shadows about you, heralds your safe arrival at the bottom, 300 feet below the surface daylight. Here you scramble out of the tub into a cavernous roadway intersected with iron rails that lead into the depths of the mine. The place is floored, walled, and roofed with rock salt, and your underground guide—a perfect type of deputy with burly frame and the quality of humour on his face—gives you a candle in a wooden slot, and your adventure begins with a prosaic but interesting peep at the stables.

Here, near the bottom of the shaft, the ponies give evidence of the healthy quality of salt. They have been down the mine for years, and are fat and sleek, with coats as glossy and smooth as velvet. And they are ever licking the rock salt at the manger head, demonstrating more conclusively than the wisdom of *savant* that salt is not only beneficial to the body, but good for the complexion. The main road to the workings is wide and lofty, and supported by great square pillars of rock salt. There is not a drop of moisture anywhere. The roadway is dusty with powdered marl. The masses of rock salt that heap and bulge here and there are dry and gleaming, and remind one of a spa cave in the Peak of Derbyshire. In the working area, which you reach by a steep path, the sight is impressive. The cavern hereabouts is very spacious; your light flashes on the roof and walls and casts grim shadows into the worked-out gulfs. Near the shaft you have been shown a seam in which amber rock salt, exceedingly rare, was found. Now you note bits of pure white rock salt, almost as clear as crystal. In the lowering roof above you all is sparkle and glitter. There are streaks and splashes of brown, red, chrome, and terra-cotta-like strata, all containing rock salt. Here the rock is dark with marl; there black with blasting; but everywhere it is a geological curiosity.

The mine, which is forty acres in extent, has a quarter of a mile of "face" or working. Along it groups of men—hewers, drillers, and shot firers—are busy at their toil. The only invention probably that has facilitated salt mining since the discovery of rock salt in the

FALLING HARD SALT IN WAREHOUSE.

WAREHOUSING SALT.

seventeenth century, is the compressed-air cutter—a broad iron framework fitted with a horizontal iron wheel strongly and sharply spiked, that cuts deeply into the rock at the rate of 180 revolutions per minute. But at the time of my visit the cutter was idle, or rather awaiting adaptation, for in future it will be worked by an electric motor. In the fitful light of many candles adhering to the rock salt face, the miners toiled unremittingly.

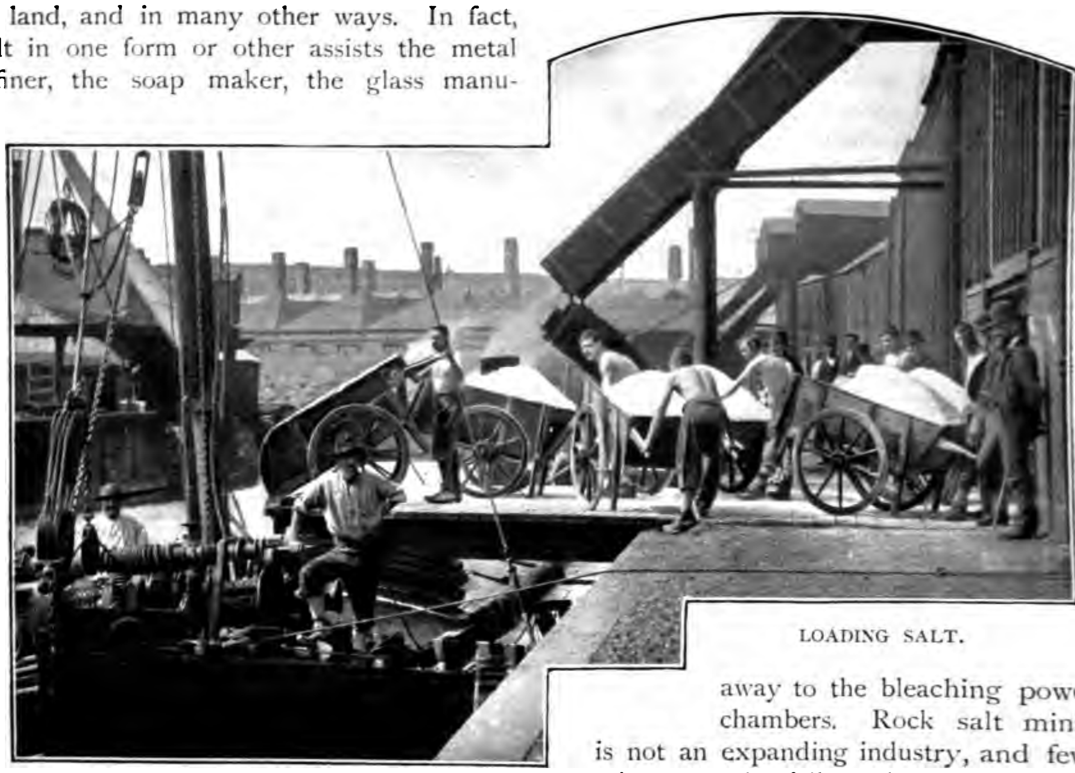
Beneath each drill hole two men faced each other, half naked, and swung their muscular arms and their picks, systematically nicking into the base of the rock a herring-bone ridge that appeared to make little impression upon the strata, and yet so undermined it that the coming shot would have sufficient room to turn over. The driller, busy at the rock above, about a yard higher than the hewers, did not use a hammer. With his stemmer or drill, an iron rod eight feet in length and diamond pointed, he slowly twisted and ground a hole into the interior of the rock. Then he rammed home the coarse powder and applied the time fuse. The latter, a straw filled with fine powder and ignited by a bit of candle wick, is only three seconds in burning. A warning is given before it is lighted, and the miners move away. They do not, as in a coal mine, hurry this way and that. They retire a few yards from the drill hole, and cluster against the wall of rock, hugging the face of the strata. The shot fires with a loud, reverberating report that fills the mine with weird echoes and rumblings, and flings half a ton of rock salt banging and clattering far out from the face. But the explosion, startling to the uninitiated, is only an incident to the hewers, and they are soon busy with pickaxe at their working place again, preparing for the next blast.

BAGGING SALT FOR SHIPMENT.

Meantime the rock salt from top or bottom bed is broken with wedge and hammer into handy size for transit in the tubs, which are run or "ferried" along the tramways to the shafts and sent to the surface. The men descend the mine at seven o'clock in the morning, break off for breakfast or "snap" at ten, and for dinner at one, and go up the shaft at three o'clock in the afternoon, when their day's toil is done. They are burly, muscular, good-humoured, and apparently contented. The work does not, like some methods of alkali manufacture, undermine the constitution or sap the vitality, and you come across hearty workers, vigorous though grey-bearded, in the recesses of the mine.

Salt from the brine is used for the table and a variety of domestic purposes; rock salt is utilised as food for animals and as a fertiliser

of land, and in many other ways. In fact, salt in one form or other assists the metal refiner, the soap maker, the glass manufacturer, and the calico printer, fixing the colouring. It is absolutely necessary for a variety of purposes in chemical manufacture, notably in the preparation of hydrochloric acid, soda crystals, caustic soda, carbonate of soda, and bleaching powder.



LOADING SALT.

In and around Northwich are extensive works which employ a large number of hands in the alkali industry. The Salt Union and other firms provide work in brine pit, rock salt mine, and in the production of chemical compounds; and on the new premises of the Electrolytic Alkali Company, at Middlewich, Leblanc's sulphur process has been superseded by electricity. The current, as it passes through the brine-filled cells, separates the sodium from the chlorine, the former yielding soda crystals, the latter passing automatically away to the bleaching powder chambers. Rock salt mining is not an expanding industry, and fewer mines are in full working; but there is practically no limit to the demand for salt from brine, or for the chemicals of which it forms a component part, and gigantic loads are sent by boat from the river Weaver, by sea, canal, and train to our great cities, and to nearly every part of the world, including Iceland and the Faroe Islands. The weight of white and rock salt exported from and coasted in Britain exceeds 1,000,000 tons per year, Liverpool, Runcorn, Weston, the Manchester Ship Canal, Fleetwood, Middlesbrough, Stockton, and West Hartlepool handling the largest consignments. At both British and foreign dinner table the superstition obtains that it is "unlucky to spill the salt," but with such an abundant supply you surely may, without wastefulness, checkmate misfortune by flinging a liberal pinch over your left shoulder.

JOHN PENDLETON.

(*The illustrations accompanying this article are from photographs by Mr. T. Ernest Leigh, Winsford.*)

THE MAKING OF WATCHES AND CLOCKS.

THE evolution of contrivances for the measurement of time forms one of the most fascinating chapters in the history of mechanical invention. Generations before the power of steam was dreamed of John Harrison succeeded in devising a marine chronometer which in many of its details is the parent of all modern watches, and he received a grant from the State of £20,000 in recognition of his genius and patience. The mechanism of a timepiece is a wonderland to child and man alike; yet, complex as it is, it is merely an arrangement of the simple mechanical powers, and one of the oldest clocks in existence was fashioned out of pieces of wood, and of wood alone. For many centuries English watchmakers stood in the front rank of the industry, and their superior workmanship was recognised even in Shakespeare's day, for has he not made one of his characters, in *Love's Labour's Lost*, describe a woman as

> "Like a German clock,
> Still a-repairing; ever out of frame;
> And never going aright."

In recent years the manufacture of cheap clocks and watches by means of swiftly running machinery has been undertaken in the United States and in certain parts of Europe, and the watch industry of Switzerland, encouraged by a well-equipped system of technical training, has made serious inroads upon the prosperous industry which made Clerkenwell in the old days one of the most thriving hives of labour in the kingdom. To speak of English watch and clock making, however, as a dying craft is very wide of the mark indeed. At this moment of writing Clerkenwell is as busy as it can be with orders for American account, and Great Britain still stands without a rival in the fabrication of chronometers, hall clocks, office "dials," turret clocks, and several other branches of the industry.

The Lancashire town of Prescot has established itself as the chief centre of the manufacture of watch materials in this country. Long before it turned its attention to watch-making it was already famed for its skill in the manipulation of small tools and files; and to-day, under the fostering care of a pioneer enthusiast, it has lifted itself above ordinary competition by the enterprise which it has displayed in devising machinery for turning out wheels and plates

WATCH-MAKING: ESCAPEMENT MAKER.

and pinions to exact gauges, so as to be interchangeable in the early stages of the birth of a watch. The work is carried on partly on the factory system and partly in the homes of the workpeople, and many of the operations are conducted by women and girls, whereby the initial cost of the skeleton of a watch is greatly reduced. This skeleton, consisting of a framework which holds together the barrel, the fusee or cone, the four wheels forming the "train," and the pinions, is called the "movement," and most manufacturers nowadays begin their operations upon rough movements procured from the Prescot factories. A large company has been formed for the purpose of carrying the work through its further stages in order to produce the finished watch in Prescot itself, and it is able in this way to produce an inexpensive English watch which competes in point of price with foreign articles of the same class. It is, however, to the makers of the better-class work that one should turn for a more typical survey of the process by which a watch is made.

WATCH-MAKING: A "FINISHER."

The most prominent feature in the picture is the amazing extent to which the industry has carried the principle of the division of labour. A cutter of wheels out of sheet brass, working with a treadle, is able to earn 30s. per week, but, as we have seen, the watch-maker usually begins by purchasing and overhauling the rough movement. The first step is to place this in the hands of the escapement maker, who may easily earn £3 per week, and he in his turn passes the mechanism on to the jeweller, who fills the holes bored by his immediate employer with the jewel holes required. Let it be noted that the jeweller is quite distinct from the jewel holer, whose task it is to drill cup-shaped depressions in tiny rubies, sapphires, or garnets by means of a hard point set in a lathe and operated with a slide rest. In the case of ladies' watches this hole may not exceed $\frac{1}{45}$th of an inch in diameter, yet its curve is carefully trimmed in order to reduce the friction of the axle of the wheel which rests upon it. As much as 18s. per pair may be paid by the wholesale maker for these holes, and as a watch of fair quality should contain four or five pairs it will be understood that in this detail alone there is a distinct element of cost. Diamonds

WATCH-MAKING: A "JEWELLER."

are seldom used, except to the balance cocks of English watches, and the importance of hardness will be appreciated when it is mentioned that the balance wheel, turning upon an axle only $\frac{1}{20}$th of an inch in diameter, would, if it travelled bicycle fashion, cover a distance of twenty-two miles every day. Some of these processes may be studied in the photographs, which have been specially secured with the courteous co-operation of Messrs. George Oram and Son, of Clerkenwell.

CLOCK-MAKING: PINION CUTTING (BRITISH UNITED CLOCK CO., BIRMINGHAM).

A large proportion of jewel holes are drilled by girls, and it is gratifying to know that America has to come to London for a good deal of its requirements in this department. There is a factory in Hertfordshire in which a dozen girls are constantly employed upon this delicate operation, and in this connection it may be added that the labour of polishing the parts of the watch is frequently entrusted to the nimble fingers of women. In other branches of the industry the feminine element is also to be met with, although women workers usually abandon the trade when they are married, and therefore seldom acquire the extreme skill which comes from a lifetime of practice. An amusing compromise was recently made by a valuable female polisher to the trade, who agreed to continue her labours after marriage, but only in the case of her husband's own work.

While these operations are in progress another workman is engaged upon the patient task of tapping a length of steel wire with innumerable taps, until it is reduced to a flat ribbon, in which form it becomes known as the hair spring. These pieces of mechanism are produced in Birmingham and London, usually by manual labour. Steam rolling is resorted to in Geneva and Besançon, but there is a well-founded prejudice among the best makers for the slower process, which is indispensable in the case of chronometers.

The making of the dial involves the attention of several distinct trades. A plate of copper is placed before an enameller, who solders the feet upon its rim, and then besmears it with a powder which is melted by heat and spread evenly upon the surface. The polishing of the white surface is an art in itself, and this being done, and the surface fired, it is passed on to the dial painter, whose days are spent in the task of painting the figures upon the dial with a deft brush. The figures are hereupon burnt in with the

MAKING CASES FOR CLOCKS.

aid of a charcoal furnace, and the seconds dial, when required, is formed by cutting a disc out of the hour dial, and cementing a thinner disc into the orifice, to allow the second hand to lie in the hollow so formed.

The several parts are now taken in charge by the springer and timer, the expert whose lot it is to attach the spring to the balance, to poise the balance, and to adjust the whole until accurate time is recorded. But before this the watch passes to the finisher and examiner, who also has to enlist the services of the case maker. The case is made by drawing gold or silver wire through hardened steel plates upon a draw bench, bending the ribbons so obtained into the shape of the circular bezels and the band, inserting into the rim of one bezel the flattened or domed disc which forms the back, and into the other the watch glass. Before the case is finished, however, it is submitted to the tender mercies of the Assay Office of the Goldsmiths' Hall, where it obtains the hall-mark, and after its return to the maker the back is engine-turned if necessary, although the proportion of engine-turned cases now called for is a very small percentage of the total output of the trade. The number of gold cases hall-marked in the year 1901 was 6,592, and of silver 3,764.

One final ordeal is reserved for the watches of the better class, that of being sent to the Kew Observatory for the purpose of being tested. At a cost of a guinea the watch is kept under observation for forty-five days, divided into eight periods, each of which tests the capabilities of the watch under fixed conditions, such as "watch with dial up in the refrigerator," "watch with dial up in the oven."

This department, which represents the refinement of watch-making, and is as far removed as the poles from the imported article which is offered for a few shillings—less than the cost of a pair of jewel holes—brings us by a natural transition to the manufacture of marine chronometers, a branch of the industry in which Great Britain has always been supreme. A box chronometer is to all intents and purposes a magnified watch, except that it possesses several delicate means of compensating for variations of temperature, violent jerking, the magnetic deflection caused by the iron in the ship, and so forth. Otherwise the same order of manufacture, by the same

specialised craftsmen, is followed, although the copper dial is usually silvered instead of being enamelled, and the hall-marked case for the pocket is replaced by a mahogany case, in whose interior is fixed a ring hung upon gimbals to preserve the horizontality of the dial in all weathers.

Marine chronometers and deck watches intended for the use of the Royal Navy are tested, not at Kew, but at the Royal Observatory, Greenwich, where the instruments are under continuous observation for no fewer than twenty-nine weeks, and are subjected to a range of temperature from 39° to 104° F. In the last recorded year the number received for this purpose was 1,118, including 24 for the Indian Government.

The mechanism of a lever clock differs in degree only from that of a watch. A pendulum clock, in which the force of gravitation is harnessed for the service of man, dispenses with the spring balance, and requires methods of adjustment of its own. Both descriptions of clocks, however, are usually manufactured on the factory principle, and there is not the same division of labour as in the case of the smaller instruments. Let us walk through a typical factory, and follow the birth of a clock through its various stages.

The wheel blanks having been stamped out of the solid sheet of metal, are poised in a cutting machine whose hard steel cutters revolve at a great speed, and cut the notches with absolute precision. Solid steel pinions are made in the same way, while lantern pinions are formed out of sections of pinion wire, which are still in some instances cut by hand. In other departments the barrels, axles, pendulum bobs, escapements, and so forth are produced, and at length the several parts are assembled in the room where they are put together to form the finished movement. Elsewhere, in an apartment whose dustiness is properly quarantined from the rest of the factory, expert carpenters fashion the wooden cases, which vary in intricacy from the simple drop case of an office timepiece to the choice pieces of cabinet work which are used for the grandfather clocks and the drawing-room instruments. There cannot be a doubt but that the French makers have captured a large section of this trade by their attention to the artistic side of the industry, although they have never been able to touch seriously the massive hall cases which Englishmen love.

There is another department of this industry in which England is still without a rival, and that is the production of turret clocks, especially when associated with striking and chiming mechanism. A clock was erected in Canterbury Cathedral in the year 1292, and there was a striking clock in Westminster as far back as 1368. Since that time the course of invention has been steady, and a landmark in the history of the industry was reached in 1859, when the great Westminster clock, designed by Sir Edmund Beckett, and built by Dent, was put into position. Special appliances have to be employed in the manufacture of apparatus of this kind, because of the mechanical difficulties presented by the sheer weight of the moving parts, the great

WHEEL-CUTTING MACHINE.

CLOCK-MAKING: PUTTING THE MOVEMENTS TOGETHER.

risk of damage through exposure to all weathers, and other considerations. When a striking train is attached to the timepiece all the parts have to be strengthened accordingly. The triumph of engineering is reached in such clocks as that erected in the Clock Tower at Westminster or in the tower of the Toronto Town Hall, the largest clock in the New World, whose four dial faces alone have a weight of fifteen tons, of which the opal glass of the transparent faces is responsible for three tons. This was produced in Messrs. Gillet and Johnston's steam factory at Croydon, where the photographs illustrative of this section of the industry were specially taken, by the courtesy of the proprietor.

A passing reference may be permitted to the art of bell casting, which at Croydon is carried on under the same roof as that which shelters the makers of wheels and pendulums. An iron core is buried in a pit, with a covering mould, and the bell metal—a mixture of copper and tin—is run into the mould with extreme care, the resultant casting being left to cool, sometimes for several days, before it is dug up again. The task of turning down the surface is achieved by reversing the bell and fixing it into a huge vice, the cutting tool being devised to travel round the periphery. By means of carillon machines, which are actuated by barrels upon which the airs are pinned out, clocks may be made to play a hymn tune or a national air every three hours, and as seven airs are usually put upon one cylinder a change may be made upon each day of the week. This, however, is to be regarded rather as one of the auxiliary industries connected with the making of clocks and watches, which also demands the exertions of the glass-blower, the leather case maker, the key manufacturer, and a score of craftsmen whose services are requisitioned in order to complete the instrument.

It will be perceived from this brief survey of the trade that the old days, when a watch and clock maker was apprenticed to his trade, and began by cutting up pinion wire, passing thence to all the other parts of the mechanism, have gone never to return. In the year 1858 the British Horological Institute

was formed, and it is doing useful work in providing young watch and clock makers with the means of pursuing their theoretical studies at evening classes, while they are engaged upon the practical study of their craft during the day. The course may be pursued for two winters, and it is gratifying to know that the sons of master manufacturers may be found seated side by side with their fathers' workmen in thus acquiring the lessons taught by centuries of experience in this absorbing pursuit.

The comparatively small place occupied by the factory system may be gauged from the figures furnished by the Chief Inspector of Factories and Workshops for 1901. He reported 74 factories in the country, with 3,501 operatives, of whom 1,554 were female, and out of this number of women no less than 582 were under the age of eighteen. In other words, watch-making is still very largely, as it has always been, a home industry.

Customs statistics must always be treated with caution, but it may be added in conclusion that during a recent year the number of watches and clocks imported into Great Britain from every source was 1,983,147 and 1,546,210 respectively. The average value of each watch was 13s., and of each clock 6s. 6d., thus showing that the foreign influx is to be feared mainly in the cheapest branches of the trade. The value of the parts of watches imported was less than £24,000, a great change having been brought about by the recent Act of Parliament which makes it an offence to put foreign movements into English hall-marked cases. Of the imported watches and clocks about 5 per cent. are re-exported, and in addition to these there was during the year in question an exportation of British watches, clocks, and parts to the extent of £83,602, of which £13,380 went to the United States.

E. G. HARMER.

(The illustrations accompanying this article are from photographs specially taken by Cassell & Co., Ltd.)

BELL-CASTING ROOM.

THE MILK INDUSTRY.

SOME idea of the vastness of this interesting industry may be gathered from the simple statement of fact that there are no fewer than 4,100,000 cows in the British Isles, and that the quantity of milk consumed in London alone reaches the astonishing amount of at least 50,000,000 gallons per annum. Day and night, year in and year out, many thousands of men and women are ever toiling throughout the whole length and breadth of the land, urged by the ever pressing demand for milk to drink. Fifty years ago the city and suburban dairies supplied London with all the milk it required. In a great number of instances the cows were kept in unhealthy sheds in overcrowded and often fever-stricken localities. Those evil days are no more; the milk used now comes from the country or from suburbs with a reasonable claim to be termed rural. Needless to say, the health of the big city has vastly improved thereby, while the increased demand in the country finds a great deal of employment for those who would otherwise crowd in to try their fortunes in the vortex of London life.

Photo: Cassell & Co., Ltd.

MILKERS AT WORK.

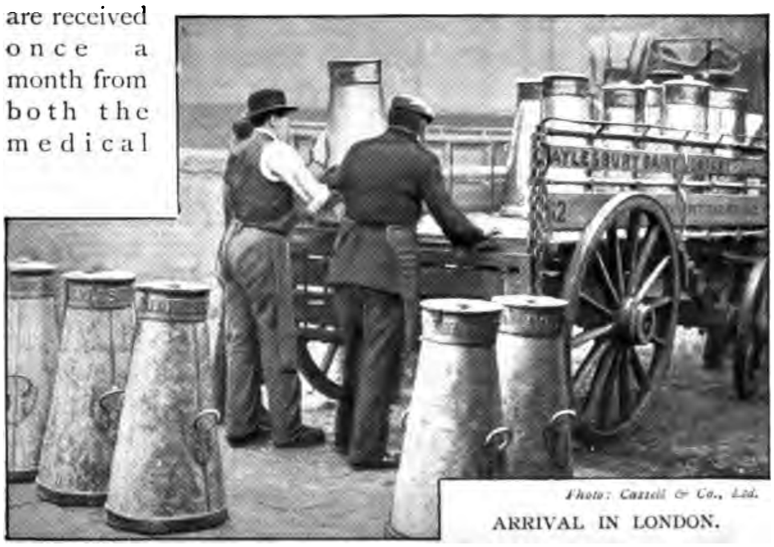
Ten thousand pairs of hands, at least, are necessary to draw the milk from the cows: for, as yet, milking machines have not ousted the dairy maid and man from their morning and evening work. Then there is the work of preparing the milk for the evening and morning trains. The consumption of the lacteal fluid has increased so greatly during the last ten years that railway companies running trains into London have laid themselves out for the business, and it is now no unusual sight to see a dozen trains entering, say, the Great Western terminus at Paddington every morning and evening as fast as the platforms are ready for them. Each of these special milk trains is made up of about a dozen vans; all built, for the purposes of the trade, on the lattice principle, to ensure a current of cool air passing amongst the great sealed cans.

Let us consider the conditions under which a large London milk distributing centre is worked. The milk is received in churns twice a day from a number of farms in various parts of the country. All the churns are

LOADING UP AT A DAIRY FARM.

sealed with a leaden seal, supplied by the receiving firm, and are further identified by marks with the farmer who has despatched them. It should be stated, in passing, that a farmer desirous of thus sending his milk to London for disposal must first agree to carry out certain precautionary conditions. These are the examination of his water supply by a medical officer, and his cattle by a veterinary surgeon. The former sends his report and a sample of the water to London, where it is chemically tested. If it is proved to be unfit for dairy purposes, the farmer is invited to arrange for a different supply; if he refuse, then his milk will not be received. Should the veterinary surgeon report also that any of his cattle are in any way defective, he is asked to withdraw them from the herd. On the farms belonging to the Aylesbury Dairy Company the water is tested twice a year, but reports are received once a month from both the medical officer and the veterinary surgeon, the former giving particulars of the general sanitary and hygienic conditions of the farm and its surroundings.

The milk being received in churns, the seals are broken, and a sample taken and tested with a lactometer. Another sample is also taken in a small can, which is sent into the laboratory for analysis. The contents of the churns is then turned into a large metal receiver, passing through pipes into a tank, being strained four times *en route.* Having been well mixed in the tanks, it is run off into the receivers below, where men are busy filling churns for the day's delivery. The contents of each churn is weighed and measured in one operation, the results being indicated on a metal dial. Each delivery cart is fitted with two churns, which are identified with the man in charge by marks — a number and initials. A sample of the milk is taken before it leaves the premises, and is tested, and any milk the man may bring back is also tested. In addition to this, inspectors are



ARRIVAL IN LONDON.

Photo: Cassell & Co., Ltd.

AT WORK IN THE LABORATORY (AYLESBURY DAIRY COMPANY).

constantly moving about on the rounds, and will unexpectedly swoop down upon a cart, helping himself to a sample of the milk then in process of delivery, for the purposes of analysis.

But now let us take a peep into the laboratory. The apartment is filled with bottles of chemicals and analytical paraphernalia. The "doctor," as the analyst is generally called, is busy among the bottles. What happens when a sample of milk reaches his hands? The specific gravity is at once obtained with the aid of the lactometer; the temperature is also taken, with a standard of 60°. The "doctor" next tests for fat. A little sulphuric acid is poured into a graduated glass vessel, with a narrow neck; then eleven cubic centimetres of milk and one cubic centimetre of fusel oil are added. The vessel is tightly corked, well shaken, and placed in a centrifugal machine for five minutes. The acid dissolves everything but the fat, which floats about in globules. The action of the centrifugal machine causes these to rise to the top and form into a layer. Then, by comparing the solids which are f and the solids which are not fat with tl specific gravity, a result is arrived at whi should agree, or nearly so, with a registere standard. If it does not, then the milk h been watered, and in all probability there trouble brewing for somebody. All tl sample cans containing milk thus tested be the name of the farm from which the milk i bulk has come, so there is no difficulty i locating the source of the adulteration.

It is in this laboratory also that the wate from the farms is tested. It sometimes happen that the water is found wrong at a farr which has been supplying milk for some time The last consignment so received is naturall open to suspicion, so, in order to make perfectly safe, it is sterilised, and converte into butter. The supply is also discontinue from this particular farm until the water i put right, or should the farmer refuse or b unable to rectify it the contract is at onc concluded. These precautionary measure sometimes lead to threatened actions fo damages on the part of angry farmers, bu

nothing ever comes of them. The principal cause of water contamination is escaping sewage.

In the case of large distributing agencies keeping their own cows the *modus operandi* is, of course, somewhat different. They run dairy farms in various parts, in which are to be found the very latest appliances for dealing with milk in various ways. The writer recently visited one of these establishments, which was admirably organised and conducted. There were many cows in residence, including some fine Kerrys, Shorthorns, and Dexters. All the stalls were labelled with particulars as to when born, calved, last record, percentage of fat, milk yield, grain feed, etc. Cows which render milk for special purposes—invalids and infants—are fed on meal and hay.

In dealing with the milk supply it really seems that the distributors have reached the superlative degree of precaution. The orthodox method of milking will not do to-day. Men are now principally employed in extracting the lacteal beverage, and the operation is performed in due scientific form. The pail is a large metal receptacle, fitted at the top with a strainer; over this is placed a layer of cotton-wool. The milk is thus doubly strained direct from the udder, and kept clear from any impurity which might otherwise get into it from the outside of the udder, the milker's hands or clothes. The milker wears a special milking suit, all white, and the hindquarters of the cow are covered with a white cloth. When the operation is concluded, the milker's clothes, the cloth from the cow, and the stool are all placed in a steam chamber. When they are subsequently taken from this they may not appear literally clean, but they are bacteriologically pure. A new piece of cotton-wool is used at every milking, a year's cost of this article alone being a not inconsiderable item. The argument for all this is that bacteria find their nourishment not in the milk itself, but in the impurities which are sometimes contained in it; it is practically a process of starving them out. When we have banished dirt we shall have heard the last of bacteria, bacilli, microbes, germs, etc.

But even these measures do not satisfy certain folk, whom the dealers are justified in dubbing faddists and cranks. Said an authority to the writer, while discussing the subject, "If we could deliver the milk in churns straight into the people's pitchers, we

DESPATCHING MILK (EXPRESS DAIRY CO., LTD.).

could do ten times the work." It is the bottling and sterilising which occupy so much time. Even the water which is used in the preparation of special kinds of milk and for cleansing utensils is bacteriologically treated by being passed through a condenser. There is also a cold storage in which the bottles of milk are kept in water of a certain temperature.

Another interesting department is that of humanising milk for infants. This entails a great deal of time and labour, and is carried out under the direction of a doctor. A mother desirous of dispensing with the natural function of nourishing her offspring will consult her medical adviser, who in turn instructs the dairyman. A milk is then prepared which corresponds as nearly as possible with breast nourishment, but it is varied in strength and quality according to the age of the child. The milk is put up in bottles, sealed, and labelled with the name of the mother. A book is kept by the dairyman in which is to be found a table of treatments, identified by numbers. The doctor instructs the dairyman, "Treatment No. —," and the milk is made up accordingly. Sometimes a child becomes ill through being fed not wisely but too well, on ordinary milk; the dairyman is then called upon to minister to it. It is calculated that to bring up an infant on humanised milk costs 2s. a day.

Frequently milk is bottled and supplied to persons going abroad, to be consumed on the voyage. For this the bottling is done quickly so that the milk has as little contact with the air as possible. Under these conditions it is possible for it to keep sweet for a twelvemonth.

The Aylesbury Dairy Company alone deal on an average with 35,000 gallons of milk a week, which they receive from a hundred different farms. The Express Company has sixty cows at its picturesque farm at Finchley, and the product of these is distributed over a very wide area. The Maypole Dairy Company have between 300 and 400 branch establishments throughout the United Kingdom. In Ireland they have about twenty. At Congleton and Market Drayton they have two dairies, both fitted with the latest and most approved appliances. In the busy season at Congleton they deal with 3,000 gallons of milk every day, brought in from surrounding farms. There are many other large and well-known firms of milk distributors whose names are as familiar to the consumer as the beverage itself.

Viewed generally the milk industry is in a healthy and prosperous condition, and consumers may rest assured that every possible precaution for their safety is taken by those engaged in the distribution of one of the greatest necessities of life.

HENRY LEE.

Photo: Cassell & Co., Ltd.

AT THE RAILWAY STATION.

THE S.S. *CAMPANIA* AT LIVERPOOL. *Photo: Cassell & Co., Ltd.*

THE DOCKS OF LIVERPOOL.

LIVERPOOL is an imposing rather than a beautiful city. A place is great, it may be said, in proportion as it appeals to the imagination. Regarded thus, Liverpool stands high in the ranks of the world's cities. It has many splendid buildings and noble institutions. That cluster of buildings of which St. George's Hall is the magnificent centre is not easily matched for grandeur in any town in England. But Liverpool is a city irregularly laid out, and the hasty visitor is mostly struck by the haphazard arrangement of the streets and the lines of dreary warehouses here and there. Comeliness is not wholly sacrificed to the utilitarian, but it is certainly less evident. In many cases the fine buildings are lost in narrow streets or among a huddle of old unlovely structures. In this respect, of course, Liverpool is by no means peculiar, but it has sharper contrasts between the grandiose and the squalid than are generally to be noted.

But outward appearance is no clue to the greatness of the city. Liverpool is the centre of a stupendous, worldwide trade; it lives, moves, and has its being by reason of its traffic with the distant continents of the globe. However parochial may seem its day-to-day existence, its interests are so extensive and cosmopolitan that the outlook of its citizens must, of necessity almost, be spacious and inspiring. Its streets are a reflection of the universal ramifications of Liverpool's mighty trade; the foreigner is very markedly to the fore among the busy throng. The commerce of the city is sensitive to a degree to the fluctuations of the world's markets, but particularly so are those homes of thrills and excitements the Cotton and Corn Exchanges.

Yet, for all its gigantic and far-reaching trade, Liverpool is comparatively young. The era of its prosperity dates back not much further than a hundred and fifty years. In 1571 a writer described it as "a decayed town," whatever that may mean; and a print of a hundred years later exhibits an unimposing little village. About the end of the seventeenth century the income from the Corporation estates reached the princely sum of thirteen pounds. The eighteenth century saw the town set fairly on its legs. At the beginning of the nineteenth century the population was 80,000; at the end it was over 640,000.

But the real history of Liverpool is the history of the docks. The first dock was begun in 1709. This old or wet dock, which contained an area of 3 acres 1,890 yards, and which was completed in 1715, has long ago disappeared, the present Custom House being erected on its site. Following the Old Dock, others were built, and Liverpool rose gradually in the ranks of British seaports. The completion of the Duke of Bridgewater's famous canal was a very material help to

the rising port, for it brought it into communication with the manufacturing towns of South Lancashire. Looking back, one sees that the growth of Liverpool as a great centre of shipping was inevitable. As one writer has put it, it had Lancashire at its back and the Atlantic in front. Lancashire was a magnet for the raw material of the world; and Liverpool is naturally the seaport for the county, through which its imports and exports most conveniently pass. The steps in Liverpool's progress are the development of the cotton trade and coal mining, the opening of factories, and the construction of railways. The rapidity with which the port has grown to its present dimensions cannot be more strikingly exhibited than by citing some available figures. In 1770, 2,073 vessels paid dues amounting to £4,142; forty years later the number of vessels had increased to 4,746 with a tonnage of 450,060, and the dues came to £23,379. By 1850 there were 20,457 vessels, the tonnage was 2,537,337, and the dues £211,743. For the closing year of the nineteenth century the figures were: Vessels 24,870, tonnage 12,380,917, dues paid £1,042,926. Naturally the abolition of sailing vessels and the increase in the size of steamers may reduce the number of vessels using the port, but the tonnage shows no diminution. To take an example, we find that in the year 1898–99, compared with 1897–98, there was a decrease in the number of sailing vessels of 410 and a decrease in the sailing tonnage of nearly 85,000, while the grand total of steam and sailing vessels showed an increase of 858 and 718,740 tonnage.

In thus tracing the history of the Liverpool Docks we have emphasised the external influences which have effectively assisted its development, but full credit must be given to the men of Liverpool for far-reaching initiative and enterprise. That Liverpool has been a pioneer is proved by the construction early last century of the Liverpool and Manchester Railway, and also by the Overhead Electric Railway—opened in 1893—which runs along the whole length of the docks, and which at the time of its opening was the first successful electric railway of any size in Europe. But, apart from that, the great shipping companies are monuments of industry. Such organisations as the White Star, the Cunard, and the Elder-Dempster lines have not been brought to their present perfection without independent conception and abundant energy. Without dock development, however, such monster lines could not exist, and so, in studying Liverpool from whatever point of view, we are forced back to those mighty structures along the Mersey banks—the pride of Liverpool and one of the prides of Britain.

Photo: Cassell & Co., Ltd.

BIRD'S-EYE VIEW OF THE LIVERPOOL DOCKS FROM THE WATERLOO TOWER.

Photo: Cassell & Co., Ltd.
ELECTRIC OVERHEAD RAILWAY, LIVERPOOL.

The docks of Liverpool lie along the Mersey, extending for seven or eight miles, like a great system of fortifications. A sea wall, broken only where entrance is required to the docks, encloses the whole distance. In that imposing range are included nearly sixty docks and fifteen graving or repairing docks; and counting the Birkenhead Docks, on the Cheshire side of the river, we have about a hundred docks under the one management.

In the early stages of their history, the Liverpool Docks were under the control of the Corporation. As the estate increased in importance, the management was delegated to a committee. About the beginning of last century, the dock ratepayers agitated for a representation on this body, and achieved the end of their desires. The final stage in the administrative evolution, however, was reached in 1851, when an Act was passed consolidating the docks of Liverpool and Birkenhead into one estate and vesting the control into one Trust. Thus the Mersey Dock and Harbour Board—a Trust which for the extent of its business has scarce a parallel—came into being.

On the Liverpool side of the Mersey the centre of the dock system is occupied by the Landing Stage, which is at all times and seasons the place towards which visitors to the city naturally gravitate; it is ever a scene of life and bustle, and from it one obtains an unrivalled view of the traffic of the river. This unique floating structure is supported on pontoons, and is connected with the shore by seven gangways, besides a floating bridge 550 feet in length and 35 feet in width for the ferry goods traffic. The stage is 2,463 feet long and 80 feet wide. Here it is that the great lines and the Manx, Welsh, and Irish steamers land their passengers. Prior to the construction of this stage and the deepening of the Mersey Bar, Transatlantic passengers were subjected to numerous delays. The big steamers were frequently detained outside the Bar, owing to want of water, and the ordinary procedure was that the passengers and their luggage were brought to Liverpool on a

Photo: Cassell & Co., Ltd.
WATERLOO GRAIN HOUSES, LIVERPOOL.

tender, and thence borne to the city stations in cabs and 'buses. Nowadays the largest steamer in the world can go alongside the Landing Stage, where a railway station has been constructed, so that almost within five minutes of their arrival passengers are on their way to London in special expresses, which run in connection with the steamers.

Before passing to a brief review of the docks, we may indicate the extent of the whole system. On the Liverpool side—which comprises the docks situate within the borough of Bootle — the total water area

Photo: Cassell & Co., Ltd.

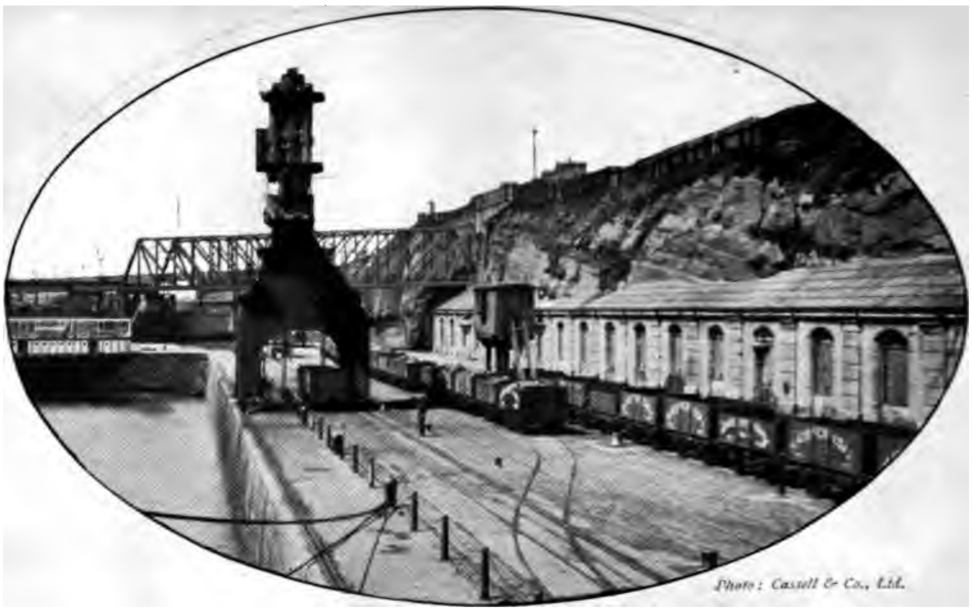
UNLOADING SAND AT THE DOCKS, LIVERPOOL.

is 392 acres 3,807 yards, and the quay space is 25 miles 923 yards. The Birkenhead Docks have a water area of 164 acres 4,190 yards, and a quay space of 9 miles 925 yards. Thus the total water area of the Liverpool and Birkenhead Docks and basins is 557 acres 3,157 yards, and the total quay space is 35 miles 88 yards. The area of the whole dock estate is 1,614 acres.

Let us now turn to a survey of the docks. First, taking those which lie to the south of the Landing Stage, we find them comparatively small, and in some cases so old as to be almost obsolete. The furthest south is the Herculaneum, which is interesting in that it has been blasted out of the solid rock, and because beside it are the depôts for petroleum, which comes from America and Russia, Liverpool importing nearly a quarter of Britain's annual supply. These depôts have also been excavated in the solid rock. There are sixty chambers altogether, each capable of holding 1,000 barrels of oil, the total capacity being over 12,000 tons. The chambers are separated from one another by a solid wall of rock five feet thick, and they are so constructed that should an accident occur the oil cannot escape and flow into the docks. From the Herculaneum extends a chain of comparatively new docks, the first of which is the Harrington with a water area of nine acres. Then comes the Toxteth with a water area of eleven acres and the most extensive transfer shed on the whole estate. This shed has a ground area of nearly five acres.

It were unnecessary to describe in detail all the docks: suffice to mention those possessing features of peculiar interest. Still in the southern system, then, may be cited the Brunswick-George group, which consists of about a dozen small docks—the oldest on the Mersey. In these the water has to be kept at the requisite depth by means of pumping. Adjacent are the warehouses of one of Liverpool's greatest trades—the importation of tobacco, in which the Mersey seaport has

LIVERPOOL DOCKS.



THE OIL SHEDS AND THE ELECTRIC RAILWAY.

a high pre-eminence. For the more expeditious handling of this enormous traffic in tobacco, another warehouse, which is said to be the largest structure of the kind in the world, has been built at the Stanley dock on the north side of the Landing Stage. This warehouse covers an area of 2¾ acres, and comprises fourteen floors. It is 725½ feet long and 165 feet wide. The floors are designed to carry 100,000 tons.

The north system, part of which lies within the borough of Bootle, comprises the newest and most commodious docks. Altogether there are in this section some forty wet and graving docks. Those nearest the stage are for the most part devoted to the very large Irish and Scottish trades. The extreme north-end docks are probably the scene of the heaviest traffic; most of the great American and Canadian lines load and unload here. The Huskisson Dock, for example, is seldom to be found without a White Star or Cunard leviathan. One of the chief trades of this part of the docks, as indeed it is of Liverpool as a whole, is the importation of cotton. The annual import to the Mersey port is nearly three million bales, which is practically eleven-twelfths of that of the whole country. Perhaps the most common sight along the docks is the lorries laden with bulging bales of cotton making their way to the numerous warehouses throughout the city.

Another very extensive trade, which is almost wholly transacted at the north docks, is the importation of grain. Special warehouses have been erected for this traffic, and at the Alexandra Dock a granary, after the style of the American elevator, has been built capable of holding 120,000 tons. The annual grain import to Liverpool is about 200,000,000 tons. The timber trade is another very large Liverpool industry. Its chief home is at the Brocklebank and Canada Docks, in the northern system. Naturally this industry demands a considerable amount of space, and along the docks mentioned there is quite a street of timber merchants' offices; and, though the aspect of the wood-yards is not very interesting to the pedestrian, the scene from the Overhead Railway — from which, by the way, the best view of the whole system of docks is to be had—is singularly impressive, the great yards with their immense piles of all kinds of wood presenting a picture that cannot fail to affect the imagination.

The Birkenhead Docks run inland somewhat, and thus seem less massive than those on the Lancashire side. The two largest, however, are the biggest on the Mersey. The West Float has a water area of 52 acres 319 yards and a lineal quayage of 2 miles 210 yards, while the East Float has a water area of 59 acres 3,786 yards and a lineal quayage of 1 mile 1,673 yards. The next in size to

them is the Alexandra, in Bootle, which has an area of forty-four acres and a quay space of 11,814 feet. On the Cheshire side the live cattle trade of the port of Liverpool is dealt with. Nearly half of the cattle imported into Britain enters by the Mersey, and at Birkenhead the most up-to-date methods are employed for coping with the traffic. When the cattle are landed they are driven to the "lairages" a few yards away, where they are slaughtered. During the season as many as 7,000 head of cattle per week are killed at these "lairages," and in a single year 300,000 have been despatched.

This vast system of docks is worked, under the administrative board and committee already described, by a large staff of workers. Each dock or section of docks has a master, who has under him a body of workers, who have charge of all that goes on within that particular territory. To watch the dock-men at work is a most interesting sight. But the sight of all to see here is, say, the *Oceanic* or *Campania* being brought out or in. A slow and deliberate process it seems—and, indeed, when one considers the size of the average liner and the immense loss should any accident occur, one understands the reason for the care and watchfulness. A tug leads the way for the liner, and another hangs on astern; and the great ship is moved slowly in the way it should go by these tiny craft. The observer notes with satisfaction that the liner is being safely handled, but he is confused by the multiplicity of advisers; the captain, far aloft on the bridge, seems to have least of any to do with the movement of the ship. Officials on the dock walls seem to be the controllers, but really those mainly responsible are the dock men, who have become expert at the delicate work by reason of long experience. At last the great ship is got safely through the narrow gateways and into the spacious Basin. There she is swung gently round by the tugs, and once clear of the entrance she proceeds under her own steam to her anchorage in the river.

From the business in great waters to the business in narrow waters is but a short step here, for canals radiate throughout the country, and this cheap and useful method of distribution is largely employed. Certain kinds of merchandise, before being despatched to their destination, are stored in Liverpool, and for these the accommodation is immense. The principal article kept in store is cotton, which is afterwards sent on to the spinning centres as it is there required. Another industry of great importance to a seaport is

Photo: Cassell & Co., Ltd.

THE LANDING STAGE, LIVERPOOL. AN ISLE OF MAN STEAMER IS SHOWN IN THE FOREGROUND.

cold storage, and Liverpool is not behind in employing this means of preserving perishable imports and of regulating the market.

Before concluding this survey of the Liverpool Docks something must be said of the dock labourer, who for all his humble station is so important a figure. The majority of the Liverpool dockers are Irish or of Irish extraction, though there is also a strong Welsh element, as might be expected in a city which has been called the "Capital of the Principality." The total number of dockers is about 18,000, and, working at full pressure, the docks supply labour for some 15,000 of these, leaving a daily margin of 3,000 unemployed. But busy though Liverpool be, it is not often that the docks keep the full quota of men working day after day. Rather must one make a considerable allowance for slack time. Thus is the docker often forced to lead a very precarious life. He has to toil under singularly difficult, even demoralising conditions. Two days a week he may be sweating in a coal-bunker and for the rest of the week be a moneyless idler. It may be that a few hours yesterday, a few to-day, and an all-night spell to-morrow constitute his week's work. His occupation is of necessity casual and fitful, and while it lasts it is physically severe. A slight improvement in the regularity of the docker's employment has been brought about by the bigger companies dealing directly with the men, but the smaller lines and the coasting shipowners still have their loading and unloading done through the master stevedores.

In this sketch of the greatness and of the work of the Mersey port, no attention has been given to the picturesque aspect of the docks and river. That, perhaps, can be readily imagined. A place so closely in contact with the far-off and wonderful parts of the world must present many curious and interesting scenes. But most wonderful of all is the grand crowded river. From the Landing Stage is witnessed a great panorama. There is a never-ending rush of ferry-boats that shoulder into the Stage, land their freight, and in a few minutes are away again laden deep with humanity. Tugs are darting hither and thither, flats with big clumsy brown sails crush along almost flush with the water, and in mid-river is always some big steamer anchored or moving cautiously to its berth; beside these, the hurrying of the smaller craft resembles nothing so much as the skimming of flies on a quiet pool.

Altogether, docks and river must appeal to the dullest mind. Than the former, man's ingenuity and enterprise have few grander monuments. At this day they are a lesson in the history of our mercantile marine, on which our national prosperity depends. They exhibit the steps by which our shipping has advanced; and if the links with the past are being rapidly removed, there remain yet material for the imagination to picture what has been—the timid beginnings, and the slow cautious, successful evolution.

JOHN MACLEAY.

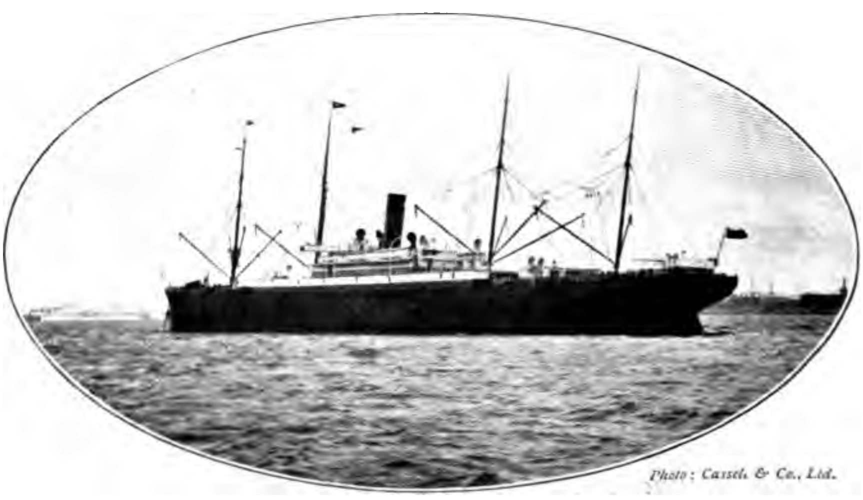


Photo: Cassell & Co., Ltd.

A LIVERPOOL CARGO BOAT.

WELSH COTTAGE INDUSTRIES.

II.—SPINNING AND WEAVING.

IN the little kingdom weaving is almost as old an art as agriculture, and is only second in importance to it. For centuries

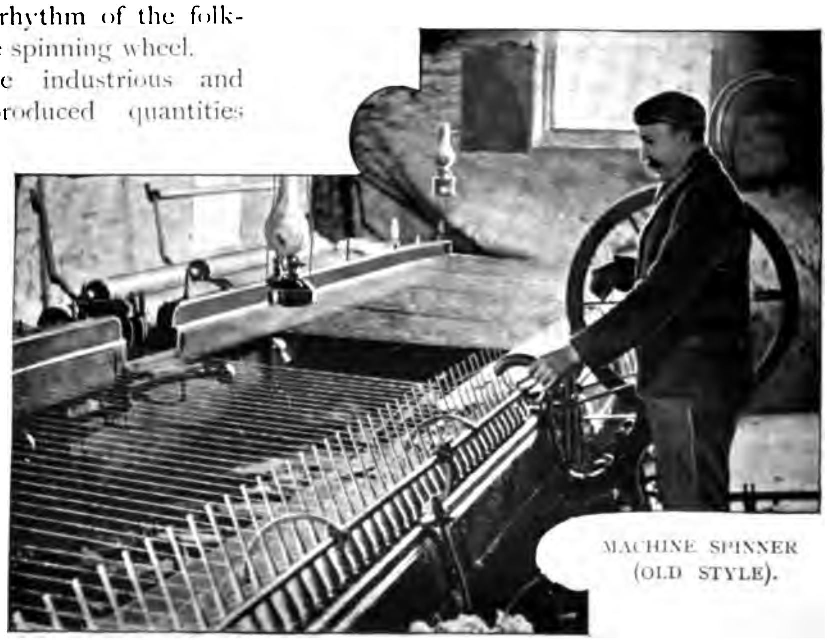
OLD WELSH SPINNING WHEEL.

the farmer was also the weaver. On winter evenings, or when the weather was inclement enough to drive even a Welshman from the fields, the good Taffey, with his family and farm hands, sat round the peat fire, winding and twisting the yarn, or laboriously working the hand-shuttle, to the rhythm of the folk-song and the whirr of the spinning wheel.

In this manner the industrious and ingenious peasantry produced quantities of cloth almost exactly like that the Flemings of the twelfth century taught their ancestors to make, when Henry I., after offering them an asylum in England from the inundations of their own country, out of compliment to Queen Maud, daughter of the Earl of Flanders, finding his party larger than he anticipated, banished his guests to Pembrokeshire that they might form a convenient buffer against the turbulent Welsh. Here they generously repaid his questionable hospitality by developing the rude weavers of Wales into the very corner-stone of the British woollen manufacture.

For over four centuries the Welshmen held the lead in the trade, selling their stuffs and "whittles" at good prices to the "Shrewysburye men," who journeyed twice a year into the woollen districts to buy it, or to the eager merchants at the Chester fairs. But the end of the eighteenth century brought the great industrial revolution due to the introduction of machinery, and domestic manufacture was crippled by the factory system. The farmer-weaver was crowded out of the market, and half the cottage manufacturers drifted to the factories, while the remainder, clinging to the methods of their fathers, contented themselves with a purely local custom.

So it happens that the domestic and factory systems have ever since co-existed in Wales, the latter constantly encroaching



MACHINE SPINNER (OLD STYLE).

[illegible]

[illegible] a [illegible]

[illegible] the West [illegible] accessible and ideal [illegible] streams that intersect [illegible] soft water [illegible] operations [illegible] hand [illegible] that the cottage [illegible] succeeding. [illegible] first em- [illegible] carding [illegible] being [illegible] processes.

[illegible] districts many [illegible] antique hand- [illegible] production of an [illegible] does not show [illegible] generations, but other- [illegible] material—the same that caused a traveller to complain that he found it impossible to sleep in a room with a Welsh [illegible]. The wool is not properly cleansed, and the natural oil though rendering it water-proof also renders it offensive. The designs are [illegible] incarnate, and the material [illegible] closely woven, and highly milled for modern degenerates who desire joy to the eyes, and distrust stuff heirlooms. However, these faults still endear it to the country population who regard everything [illegible] by the Flemings' receipt as [illegible]. So the unambitious weaver still earns a precarious livelihood by producing

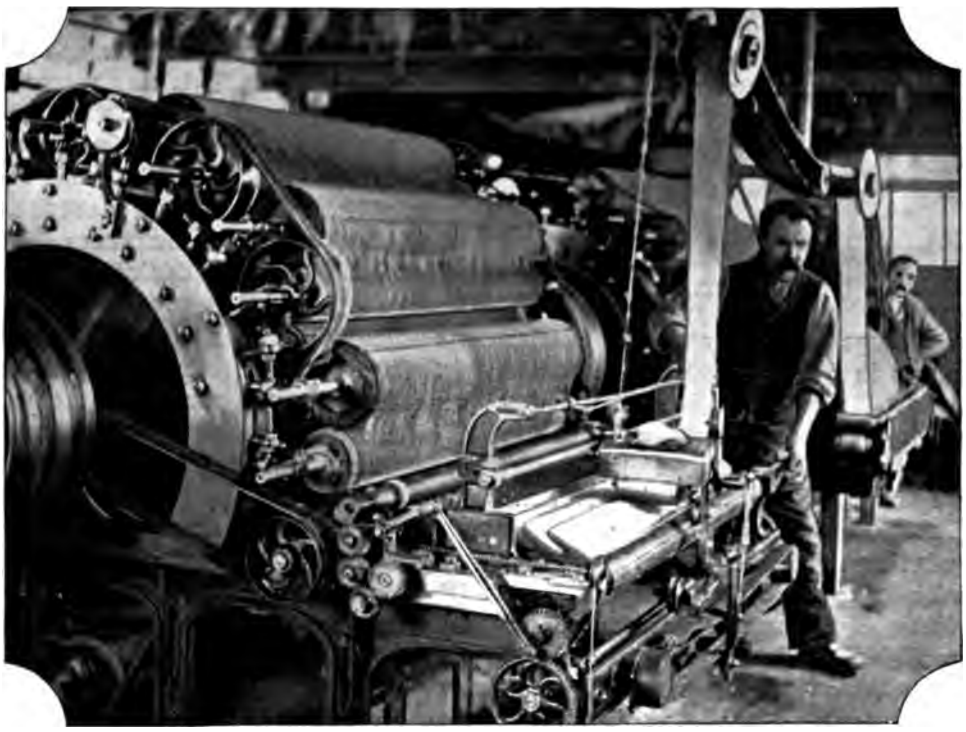
on the former. Recently, however, partly owing to the spread of [illegible] to the efforts of the Welsh Industries Association [illegible] up the [illegible] product to [illegible] in regard to texture, pattern [illegible] the domestic [illegible] held their own; they have, in fact, considerably extended their market.

There is much in the weaver's art that is admittedly done better by hand than by machine. The sympathetic fingers can help a tender place in the yarn where the machine would break it, causing a defect unnoticeable in the "milled" cloth, but very quickly discernible when the fabric is in use; the hand-woven material does not shrink, because never stretched to the unnatural tension of the machine-made

SPOOLING MACHINE.

two yards of narrow, stubborn, waterproof flannel in sixteen toilsome hours. But he is fast dying out. His children have made the streams their servants, set up larger looms, studied modern needs, and outgrown the faults, while retaining the virtues, of the fabric of their forefathers.

Carmarthenshire, Cardiganshire, Pembrokeshire, Montgomeryshire, and Merionethshire are the woollen centres of to-day. They



CARDING MACHINE.

show an increase of about 9·5 per cent. of weavers during the last ten years, which, considering the total population of each of these counties (excepting Carmarthenshire) has seriously declined during the same period, is a more substantial one than at first appears.

In Wales and Monmouthshire there are now over 1,000 factories and workshops, employing 1,842 men and 980 women, and 584 power-looms at work. The cottage weaving machines vary from the first fly shuttle 22-inch loom to the latest improved Jacquard extra double-width power-weaver. But the hand-loom is very generally used. It produces about twenty yards of material in a day of twelve or fourteen hours.

Usually whole families are employed in this industry. Homes are thus kept together happily and profitably, and the depopulation of the rural districts checked. The fact that these workshops exist and increase in the face of the enormous factory competition seems to point to far larger possibilities.

Many of these little factories are but the picturesquely thatched and whitewashed cottages dear to the artist. The evening primroses and hollyhocks in the garden patch are spread with bleaching stuffs, and the gnarled apple trees roped from bough to bough with drying yarn. Behind the cottage is the long, low weaving shed, where, perhaps, as many as three busy looms are working. Two of them will probably be hand-looms, but the third, and pride of the weaving family, is, in all likelihood, driven by the little stream that rushes noisily down the hill through the garden, and can earn as much in a day as the other two in a week.

Above the weaving shed is a loft where sacks and haycocks of wool are stored, and giant balls of worsted yarn are laid ready for the greedy looms. On the other side of the busy, littered yard is the wash-house, with

DRYING WOOL AND YARN ON BUSHES.

its row of huge coppers, and the wooden screw-presses in which the finished material is "milled." Beyond this is a much discoloured plot of ground, scattered with the ashes of many fires, broken pots, and wooden spoons, where the dyeing is done in huge cauldrons over earth ovens.

The winding machine and pattern board are usually kept inside the cottage for the leisure hours of the female workers. Often every available space in the picturesque kitchen is crowded with "prins," "spools," and skeined yarn. Sometimes they even encroach on the parlour, usually kept sacred to "the Book," Sundays, and funerals, until the busy housewife has time to store them in the big wall cupboard by the settle, where she keeps her patterns and order-books.

The wool is bought direct from the farmers, the price paid being usually about ninepence a pound. It is sorted fine and coarse, and carefully washed by the cottage weavers, who then send it to a local factory to be spun. Spinning factories are now usually worked by water power, and are separate from the weaving factories, though some weavers own small yarning machines. The picturesque spinning-wheel of old has degenerated into lumber, unless it has been bought and promoted to the high estate of a boudoir curio.

Carding, too, is often now performed by machinery. Machines calle the "tucker," "scribbler," an "carder" are in general use. Bı for specially fine kinds of materi the wool is carded by hand, o account of the softe finish obtained. Th same friendly torrer that moves the grea spinning machine doe the winding an skeining for th cottage spinner, wh is also responsible fo the cleansing of th yarn from the oil h mixed with it in it manufacture, an sometimes for th dyeing of it ; but th superior dress good are usually dyed after they are woven.

Spinners receive from threepence to fourpence-halfpenny a pound for the spinning With a machine carder they can work ninety or a hundred pounds of wool in two days, working fifteen hours a day ; they thus earn £2 to £3 a week, allowing for working expenses.

The dyeing is now the chief problem the Welsh cottage weaver has to face. His looms have been improved, and his taste in patterns has been educated ; he has learned to thoroughly wash the oil and grease from his wool, to spin it so that it shall be light and soft, as well as strong and durable, to apply power where desirable while retaining the excellence of his hand finish, and to admire his product without that hard and shining surface from over "milling" that was so dear to his ancestors ; but to obtain the delicate, fashionable colours remains with him a technical difficulty, and he is often obliged to send his dress materials to the great dyeworks of England and Scotland. So far in this matter he has no sort of combination, and must pay for his dyeing, carriage, etc., at the ordinary retail rate ; the natural result being that, as he finds this class of goods gives him more trouble and less profit than flannels, tweeds, petticoats, and shawls, he deserts it for them. Yet it is in the finer hand-finished stuffs that he is so capable of excelling.

The Aberystwith College has already taken action in this matter, and extension lectures and technical schools are now being organised. A little instruction and initial expense are alone needed. The Welsh have always been expert dyers of the old sort. There is the famous secret black dye of Carmarthenshire, the concoction of which is now known only to one old spinner, who intends communicating the receipt to his nephew on his deathbed. It is a pity a less limited use cannot be made of his knowledge, for the black is perfect, and, however old or maltreated the fabric that has once received it may be, it is never rusty. The generally known dyes are vegetable, and are mostly collected by old women from the woods and hedgerows. Ragwort, damson, crottle, logwood, seaweed, and imported indigo are stewed mysteriously in the witch-like cauldrons. The range of colours produced is, though small, pretty and absolutely trustworthy in sun or rain.

The natural wools of Wales are particularly good. There is a breed of black sheep from whose coat a rich dark-brown cloth is produced, and another of different ilk whose winter wool becomes a pure blue-grey tweed, while the white fleece of the mountain sheep should easily rival the finest German white wool goods.

Until the technical difficulties of scientific and artistic dyeing are mastered it must be in the manufacture of these white and natural goods that the cottage weavers succeed. Their natural shirtings, flannels, tweeds, breeches cloth, petticoats, and shawls, in pattern, colour, and texture, compare favourably with the best in the market, while as the result of self-preservation in the Welsh climate everything produced on the cottage looms washes well, without shrinkage; and the wearing-out of a Welsh coat is still a matter of much time and difficulty.

Welsh cottage weavers of to-day earn about £1 a week. This means eighty yards of flannel at the wholesale price of fourpence-halfpenny a yard, less one-third for attendance of boys, shuttles, looms, etc. Often his profits are further docked by one-tenth, owing to his lack of combination in selling, which necessitates his trudging to the fairs and markets with his produce, in the mediæval manner of his ancestors.

MARY BARBER.

(The illustrations accompanying this article are from photographs specially taken for the purpose, and are the copyright of Cassell and Co., Ltd.)

WELSH FLANNEL STALLS, CARMARTHEN MARKET.

THE MANCHESTER SHIP CANAL. *Photo: Priestley & Sons, Egremont.*

THE ENGINEERING INDUSTRY.

ENGINEERING has a much wider scope to-day than it had two thousand years ago, when Archimedes discovered the theory of the lever, the utility of the pump, and the lifting power of the derrick. The modern engineer alters the earth's surface, flings bridges over ravine and arm of the sea, tunnels beneath mountain, climbs rugged slope, dives into mine, and burrows under great city. He makes land and ocean travel easy. He is the universal helper of industry.

The civil engineer has the highest social position; but the mechanical engineer has a position of great usefulness, because his work is infinite, and his invention and handi craft tend to decrease human slavery, an to make life less laborious, brighter, an happier—though to the end of time som men seem destined to the inexorable fiat tha they must earn their bread by the sweat o their brow.

There are many branches of engineering —civil, railway, mining, sanitary, milling marine, naval, military, and electrical; and with the newer application of science to industry, the aërial engineer may soon put his brass plate on door of city office, though his working plane will inevitably be the firmament.

SWING BRIDGE OVER THE WEAVER.

THE OPENING AND CLOSING OF THIS IS EFFECTED BY MEANS OF AN ELECTRIC MOTOR WORKING ON A CONTINUOUS WIRE ROPE.

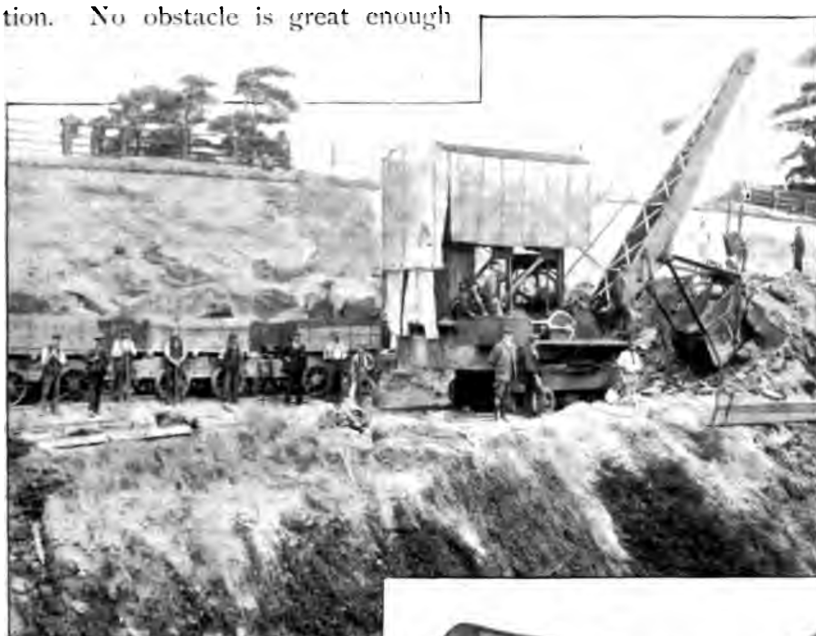
(Photo kindly lent by Messrs. Mather & Platt, Ltd.)

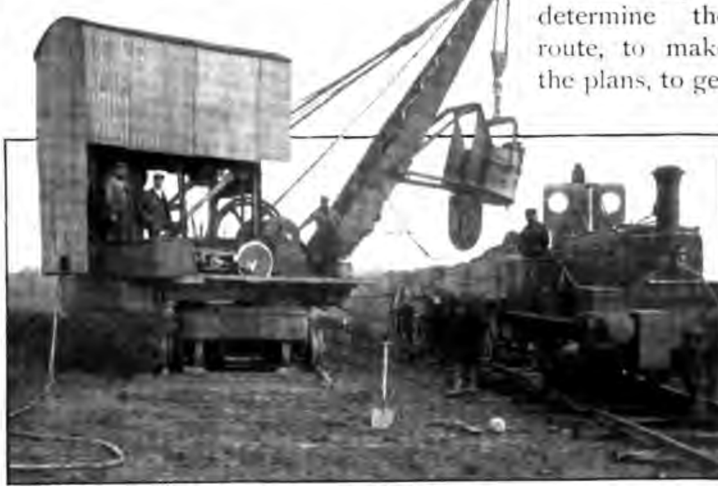
The engineer, civil or mechanical, is indispensable to the railway, for it is on his capacity to design, construct, or equip that the line depends. Telford, the builder of the Menai Suspension Bridge, the maker of the Caledonian Canal, and the delver of St. Katharine's Docks, was the most notable civil engineer of the opening of the nineteenth century; but George Stephenson, the father of the English railway system, was more versatile—he combined both civil and mechanical engineering. In his career mechanical engineering had the first place, civil engineering was simply an accessory or an incident. His inventive genius was concentrated on the development of the locomotive;

the track it ran on, the bridge it crossed, or the tunnel it shrieked through, was merely an industrial consequence of the engine's progress.

But since his day civil engineering has reasserted itself as the brain power, in contrast to the mere labour of construction. No obstacle is great enough to daunt the civil engineer; and his fight with and control of Nature became more dogged and complete in the middle of the last century, when Robert Stephenson in the north and Brunel in the south, both civil engineers of eminence, were rivals in the principle of railway construction, and particularly in width of gauge and in bridge-building.

As a proof of Robert Stephenson's shrewdness with regard to width of track, the Great Western Railway Company, after clinging to the broad gauge for many years, abolished it and adopted the narrow gauge throughout their system ten years ago. The use of the stationary engine has been revived on electric tramway and railway, but the moving locomotive has superseded it on the steam-power railway; and though the suspension bridge has still its defenders, the rigid bridge is in greater demand. The Forth Bridge, engineered by Sir John Fowler and Sir Benjamin Baker, a giant among dwarfs in comparison with other bridges, is formed of three enormous cantilevers, or brackets, resting on three huge piers; or, to give a more graphic description, the piers might be Herculean men sitting in huge chairs, and grasping with each hand the horizontal connecting girders that uphold the track. The extension of railway travel and of goods transit has led to the establishment of an engineers' department on every great railway, and the chief engineer is really the general servant of the company. It is his duty to determine the route, to make the plans, to get Parliamentary sanction for the line; to engineer the various works, sidings, stations, viaducts, bridges, and tunnels; to be on the alert for possible extensions; to efficiently maintain the permanent way; and on some systems to maintain canals, docks, and landing stages.





THE STEAM NAVVY AT WORK.

Photos. kindly supplied by Messrs. Whitaker Bros., Ltd., Horsforth, near Leeds.

Nevertheless, he is absolutely powerless without the output of the mechanical engineer,

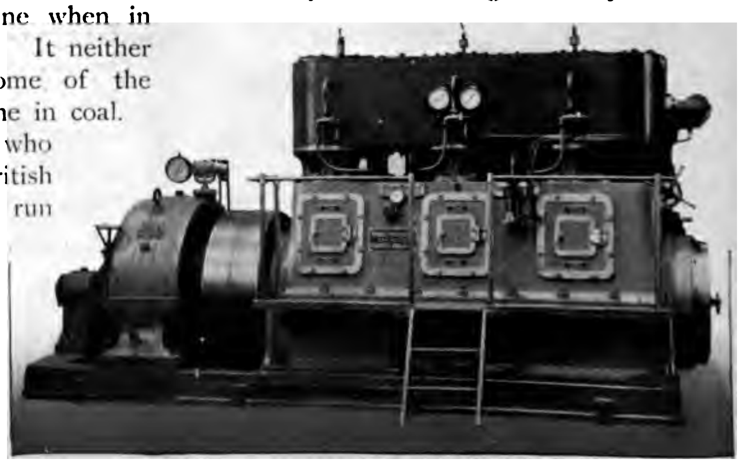
CALICO PRINTING MACHINE.
(Photo supplied by Messrs. Mather & Platt, Ltd.)

by whose industrial skill nearly everything in use on the system, from the Bessemer rails to the luxurious train and the signalling apparatus, are produced. The works of the Great Eastern, Great Northern, Great Central, Midland, Great Western, and London and North Western are striking examples of what can be done in the direction of mechanical engineering. They are all capable of turning out a complete railway equipment, and excel in locomotive making and building.

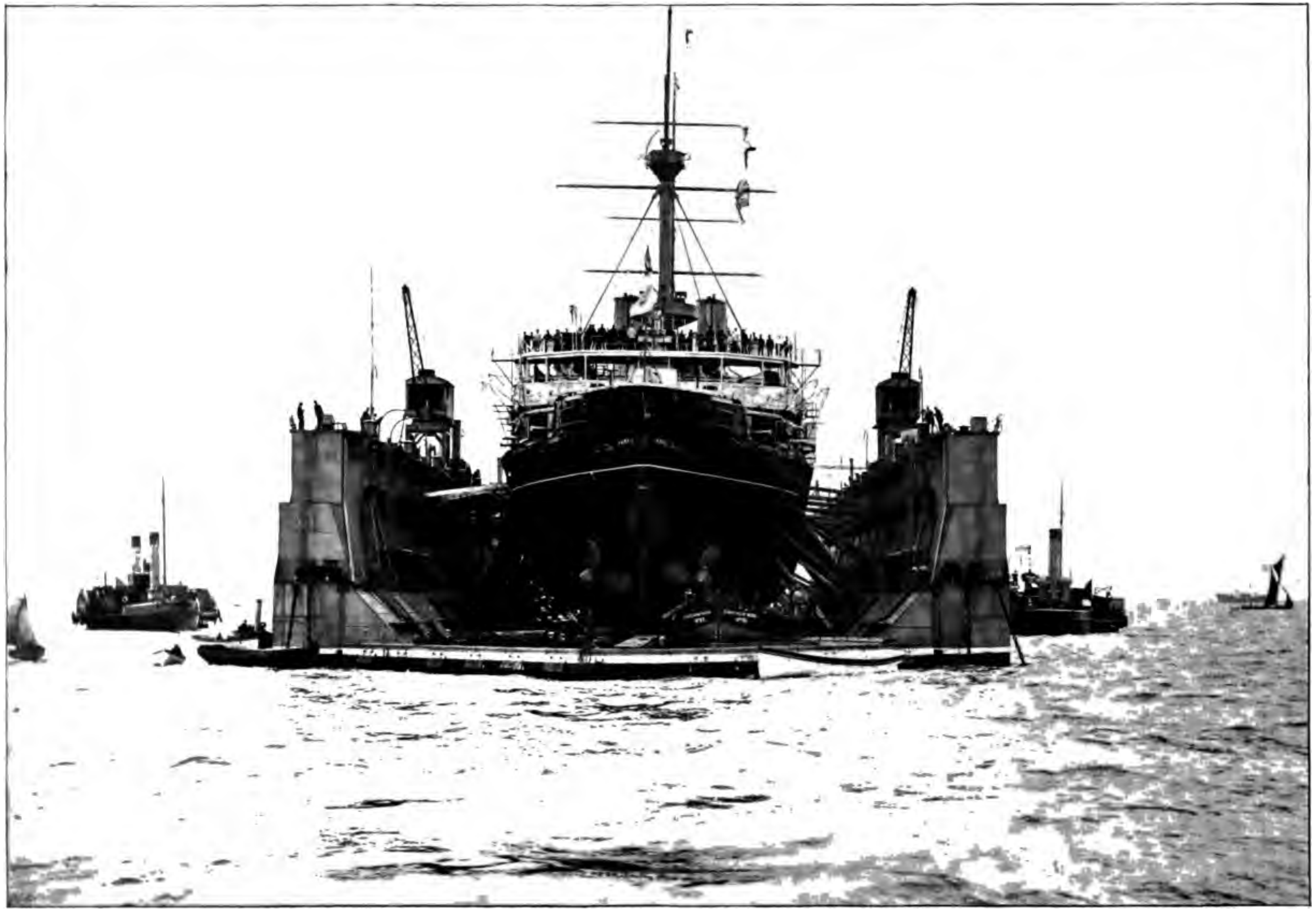
The London and North Western Railway Company, sending upon their track a grand type of locomotive that runs over a mile a minute between Liverpool and London, are not averse from the interchangeability of parts in engine-building, particularly of cylinders, valves, connecting-rods, axle-boxes, and other fittings. They can, at their Crewe works, erect a locomotive in a month, in a fortnight, or, in emergency, in a day; but, however quickly they build it, the engine when in steam is a credit to the builders. It neither leaks nor runs away, like some of the American engines, with a fortune in coal.

Meantime, the pessimist who croaks about the decadence of British industry would do well to run through the Salford Ironworks of Messrs. Mather and Platt, Limited, at Manchester. The whole place is alert to keep abreast of the foreign competitor, and that even with the fairest and most healthy conditions of employment and the adoption of the eight-hours day. No labour-saving device is neglected, either for the outside market or for use in the works. There is the swish of plane and the noise of hammer in the pattern shop, the clang of toil in the forge, the move of men in the foundry, and the tinkling din of a thousand bits of brass in the upper storey, in which valves and all small fittings are fashioned by machine and hand; but the great shops, particularly the erecting shop, are comparatively silent. Nearly all the machinery is driven by electric motors, and the machine tools, moving automatically and doing their various tasks, from the manipulation of the raw material to the output of the finished article, give one the notion that, instead of finely created contrivances of iron and steel, they are sentient beings; though, like Galatea, they are without the gift of speech, and do not argue whatever burden of work they have to bear.

In the mechanical engineering shops much heavy machinery and appliances are in course of making and building. The huge filters, gravity and pressure, for filtering the water from lake or river for town or village supply, or for the purification of effluent water from factories, look like iron-clad fortresses. The surface condensers built for the Manchester Corporation, to condense the exhaust steam from the engines driving the dynamos that work the city electric tramways, are perhaps the largest of their kind in the country, and distinctive for careful workmanship both in their huge castings and brass tube plates. Here is a stationary armature ring for a dynamo for



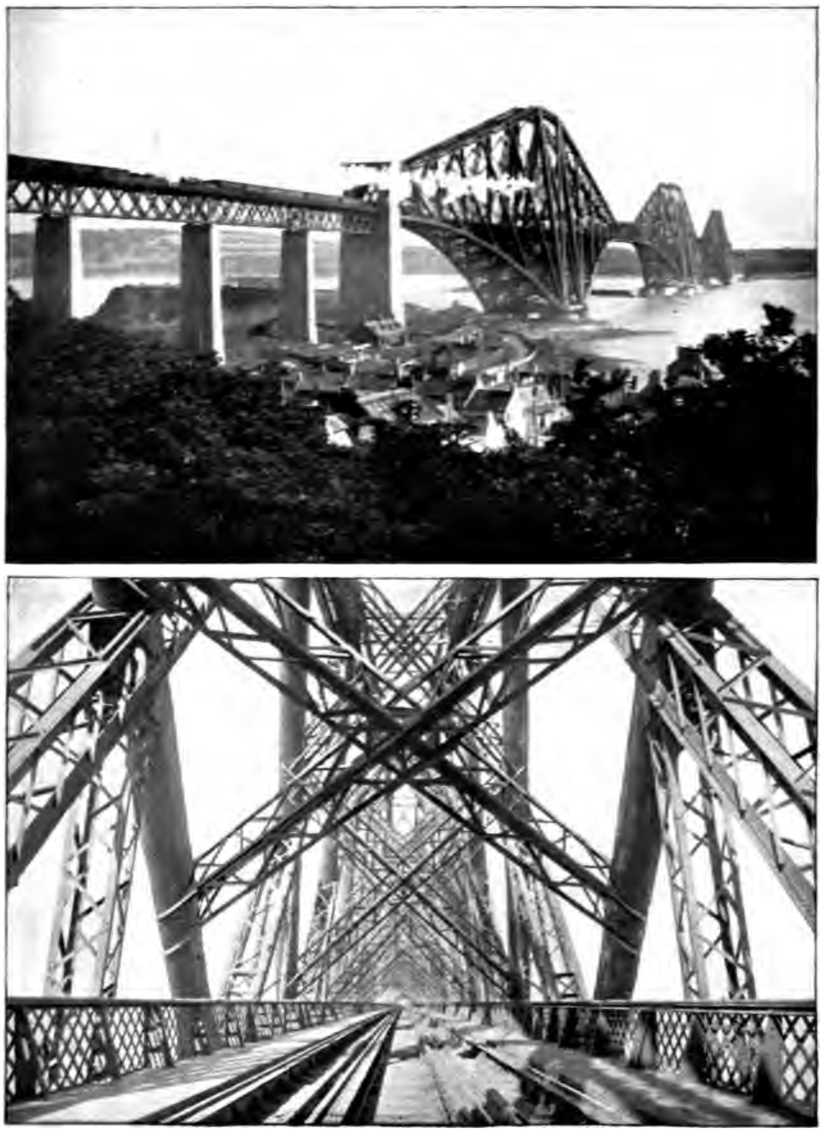
A GREAT STEAM DYNAMO.
(Photo supplied by Messrs. Browett, Lindley & Co., Ltd., Patricroft, near Manchester.)



THE NEW FLOATING DOCK FOR BERMUDA, BUILT BY MESSRS. C. S. SWAN AND HUNTER, LTD., WALLSEND-ON-TYNE.

electric power and lighting purposes, really a gigantic wheel, capable of far greater possibilities than Holbein's "Wheel of Fortune"; there is an improved high-lift centrifugal pump, which, coupled to an electric motor, will force water to a head of 120 feet with a single chamber, or 360 feet with four, and at an efficiency of over 70 per cent.; and yonder an electrically driven three-throw variable stroke pump, so nicely adjusted that, while the speed of the motor remains constant, the stroke of the plungers can be altered by hand even when the pump is running.

These, and many other apparently cumbrous machines, are toyed with without any great physical strain. Yard and shop are equipped with ground or overhead travelling cranes; and the heaviest castings are brought with celerity and placed in position in the fine erecting shop as easily as if they were feathers. The mechanical engineer seems to be a swarthy and robust chrysalis of the electrical engineer. The two departments are interdependent, and both go to make a perfect whole. The fact is demonstrated in a hundred ways in the various shops in which open or closed steel-clad motors, compound engines, condensers, dynamos (including the Edison-Hopkinson dynamos), pumps, and textile machinery (including electrically driven calico printing machines, and a very skilfully constructed sample colour printing machine for the Tokio School of Technology in Japan), as well as all kinds of ingenious appliances for sewage purification and sanitary engineering, are made.



TWO VIEWS OF THE FORTH BRIDGE.
(Photos: Cassell & Co., Ltd., and G. W. Wilson & Co., Aberdeen.)

In every part of the works, from the pattern shop to the gallery of the erecting shop, where the great armatures are being equipped for their electric work, there is evidence of strenuous brain, originating and controlling mechanical and hand labour; and with all this activity and responsibility the head of the firm, Sir William Mather, M.P., is essentially broad-minded, and has looked far beyond his workshops, in his well-doing, to the

LONDON AND NORTH-WESTERN RAILWAY FOUR-CYLINDER COMPOUND PASSENGER ENGINE.

(Photo kindly supplied by Mr. F. W. Webb.)

Valley of the Nile. During his visit to Egypt, while at Khartoum, he offered, entirely at his own expense, to equip the Gordon College with engineering plant, with a view to manual training of the natives. This he is doing; he is fitting the school of English technical instruction in the far-away desert with steam and electric engines and machinery, and with tools of various kinds for working in wood, lead, iron, and steel, so that the sons of the followers of the Mahdi may become adept in the elementary arts of mechanical engineering.

The existence of the mining engineer is chiefly remembered at the time of great colliery disaster, when he is prominent, and often heroic, in his efforts to save life; but his daily work is equally responsible. He has to gauge the lie of the mineral, show the trend of the workings likely to be safest and most profitable, to insist on proper propping, to institute haulage and winding; and, now coal-getting has been to some extent removed from mere hand labour to an expert industry, he must be ready, whether civil or mechanical, to avail himself of every improvement in machinery. Perhaps the greatest recent innovation has been in the method of coal-getting itself. The miner has for years picked the coal from beneath the face of the strata; now in some pits the coal-cutting machine, run along rails to the edge of the coal face, whirls its great wheel, driven horizontally by compressed air or electric motor, into the solid coal, and cuts it to such a depth that the upper part of the seam falls by its own weight. The machine is worked by the miner in a sitting posture; and he can get far more coal with it than with the more irksome and laborious pick.

Photo: A. B. Hughes, Norwood.

CONSTRUCTING A RAILWAY.

Photos: Cassell & Co., Ltd.

SCENES IN A GREAT ENGINEERING WORKS (MESSRS. MATHER AND PLATT, LTD.).

The great city not only throbs with life and energy; it is, despite its impurity of atmosphere, often healthier than the hamlet, because the health committee of the corporate body and the sanitary engineer combine to make it clean and wholesome. The copious supply of filtered water, the extensive system of drainage, the clearance of rubbish, the scientific purification of sewage, and the prompt destruction of refuse all tend to the comfort and health of the people to a far greater degree than the haphazard conditions of life in a rural district. The engineer has abundant opportunity, in the focussing of immense populations in great cities, to show his resourcefulness; and in connecting such lakes as Thirlmere and Vyrnwy with Manchester and Liverpool for water supply, in vast schemes of drainage and other hygienic projects, and in the electrification of the tramways, he has exceeded the estimate of Confucius as a benefactor of mankind, for he has conferred upon society both pleasure and profit.

The engineer is necessary to the building and manning of the ships that have made Britannia mistress of the sea; and he designs and rears the lighthouses that safeguard the vessels from wreck. There is no great work and no important industry that is not the better for his thought and energy. He is vital in peace; he is indispensable in war. The Army would be a feeble thing without his weapons and engines of offence and defence; the Navy has been revolutionised by his fertility. The old three-deckers have given place to battleships with armour-clad hulls of hardened steel, and fitted with defensive machinery and gunnery, scientific and deadly. The triple-expansion engine and the twin-screw have given greater speed; smokeless powder, the quick-firing gun, the electric search-light, and a hundred ingenious appliances have intensified modern naval warfare. There is no limit to the possibilities of an engineering career on shipboard, and in the invention and construction of new styles of war-ships; and one of the most unique developments of industrial enterprise is seen at the works of Messrs. Vickers, Sons and Maxim.

The firm not only make defensive armour, but they turn out projectiles that will go through it as if it were gingerbread, so that whichever is worsted in a naval engagement Messrs. Vickers have the best of the argument. At Barrow-in-Furness they have adopted contrivances that would have amazed English engineers in the mid-Victorian era. The self-charging furnaces are a revelation to pig-iron makers accustomed to the waggon-load feeding of blast furnaces; and electricity is applied to steel plate puncher, or machine

Photo: W. Heath & Co., Plymouth.

THE EDDYSTONE LIGHTHOUSE.

bolt maker, or moves the huge cantilever crane that travels noiselessly along the lofty platform, with gigantic arms outstretched, dropping an armour plate here or a capstan there on battleship in process of building as easily as if they were toys.

What strikes one about engineering is the magnitude and diversity of it. Engineering appears to be a huge grapple with the forces of Nature, and inclines the faint-hearted to say that a great engineer is born, not made; but there is no reason why the well-educated, industrious youth, with a liking for the civil, mechanical, or electric side of it, and with a vigorous mind and opportunity of workshop practice and technical instruction, should not rival in notable work the engineers who have made a name in history.

JOHN PENDLETON.

STREET INDUSTRIES OF LONDON.

A STREET MUSICIAN.

IN London, street industries form a much more important feature of open-air life than in any provincial city. Alike in number, variety, and service to the community, they are peculiar to the Metropolis, which depends on them for the satisfying of its daily needs to an extent not paralleled elsewhere.

Among those who follow street occupations in London the costermongers are the most numerous class. They number between sixty and seventy thousand, and sell not only perishable goods, but earthenware, old clothes, books, sweets, etc. Some of the vendors of fish, fruit, and vegetables are like ordinary greengrocers, and possess rounds which they work regularly; some—"draggers"—ply their trade in the gutter of business thoroughfares; and some stand in the street markets, of which there are more than one hundred in the Metropolis, from busy, frowsy "Petticoat Lane," with about eleven hundred stalls, displaying everything, from pickled gherkins to second-hand cameras and surgical instruments, to suburban marts containing fewer than a dozen stands, and those given up to nothing beyond fruit, vegetables, and fish. The men who sell articles which will keep for an indefinite period invariably carry on business in these street markets, or, as the costers say, market streets, or on isolated "pitches," and for this reason they are technically known as "pitchers."

There are several grades of costermongers. In the first rank are the men who own a barrow and a pony or donkey; next come those who hire a turn-out at a cost of about 6s. per week, plus, of course, the keep of the animal; and below these, perhaps the largest section of costers, are the industrious and resourceful street merchants, whose stock is set out on a hand barrow, hired at the rate of 1s. per week. Numbers of such men sell on commission. A prosperous costermonger in many cases provides a dozen or score of them with both stock and barrow. For the barrow, which he himself has hired, they must pay at the usual rate; the unsold stock they return to him, and give him a percentage of their takings for his trouble and risk.

Without exception, costermongers, whether "big" or "little" men, are a hard-working class. The fish vendor has to be astir in the small hours of the morning, to get to Billingsgate betimes, while the fruit and vegetable dealer is usually at Covent Garden, the Borough, Pudding Lane, or Spitalfields, long before London is awake. Sometimes he visits all these markets in turn, and in the end finds nothing worth buying. Prices rule too high. Occasionally, the lot of the suburban coster is still harder. As a rule, he does his marketing in the afternoon, purchasing then the commodities that he will retail on the following day. But, after pushing his barrow for five or six miles to Spitalfields, he may be unable to get what he wants, and consequently have to rise at three or four o'clock next morning and go over the ground again. Costermongers, in fact, are among the most hard-working members of the community.

Included in the ranks of these street hawkers are a good many men who, while

GREENGROCER.

FLOWERS AND SALT

not strictly costermongers, are generally classified as such. There are, for instance, vendors of salt and hearthstones, firewood, and other household necessaries. The firewood dealers are, in a sense, manufacturers as well as retailers, since they purchase the raw material, saw it into lengths, chop it up, bundle it, and, finally, sell it. Their wood they obtain in various forms from many quarters — sleepers from the iron road, beams and planks from old buildings in process of demolition, packing cases from warehouses. In the winter you may see scores of them hovering round a road that is "up," in quest of the old blocks, which, though practically worthless for fire-lighting purposes, make excellent chump wood or logs. Notwithstanding the many sources of supply open to firewood merchants, however, they are not infrequently thrown on their beam ends through their inability to obtain any stock.

A less important industry of the street is that of the musician. To him London is, in general, a place of hibernation. In the summer he is on the road or at the seaside; it is only during the winter that he is in town. Alone, or in company with other instrumentalists, he then "works the pubs," plays to the people waiting outside theatres and music-halls, and makes "pitches" just out of the full tide of traffic. In his most familiar guise he is a cornet player or "blower," and he usually takes up his stand on the edge of the kerb.

Chair-mending, tinkering, and knife and scissor grinding constitute another class of street industries. The number of itinerant chair-menders is yearly becoming smaller, probably because much of the work formerly monopolised by them is now done at the institutions for the blind; and tinkers are likewise, but for another reason, dwindling rapidly, though they may often be met on the fringe of Greater London. Grinders, on the other hand, are as numerous as ever. Even they, however, feel the pinch of foreign competition,

SUNDAY MORNING SCENE IN "PETTICOAT LANE."

[illegible]

stood all day for less than a shilling, whereas during a recent year the average weekly receipts of each lad in the Central Red-Shoeblack Society—the oldest organisation of its class, having been founded by "Rob Roy" Macgregor in 1851—were £1 5s. 2d. The total earnings for the year amounted to £[illegible] 5s.; and during its existence the society has received from the public for shoe-blacking no less a sum than £[illegible].

for chestnut-roasting, is one of those occupations which maintain the Italian colony in Clerkenwell.

Boot-blacking is one of the great industries of the London streets, giving employment as it does to nearly one thousand persons. Those who follow it are, with the exception of the boys attached to the Central Red-Shoeblack Society, licensed by the police—who issue about 800 permits every year—and compelled to keep to the particular "pitches" for which they are licensed. They cannot roam about at will; they must stop at such places as are assigned to them, however unprofitable they may turn out.

The value of "pitches" varies enormously; but it may be taken that the adult shoeblacks do not earn nearly so much as the boys belonging to the various brigades. Men have

Admirable is the system on which this useful society is worked. When a boy is admitted to the school—and no applicant over 16 is turned away if there is room for him—he is provided with uniform and implements out of the general funds. He is then given a "pitch," the first sixpence he takes at which he is allowed to spend on a dinner. The remainder of his earnings are divided into three equal parts—one-third he retains for himself as his day's pay, one-third is kept by the society to meet his expenses in the home, and the remaining one-third is reserved as a "bank" for his benefit. And this apportionment is repeated day by day; so that the boy gets 6d. more than two-thirds of his earnings per diem. But he does not

CHAIR MENDERS.

keep to the "pitch" on which he begins. With a view to giving all the same chance, the superintendent shifts him every three or four days.

Some boys derive lasting benefit from the society. It is not uncommon for a lad's "bank" to amount to £20 or £30. Numbers of the youths, too, pass into the Army and the Navy, while others go to the Colonies or obtain permanent and remunerative employment at home. If, indeed, a boy does not profit by the society's efforts, he alone is to blame.

Coffee-stall keeping is a business rather than an industry; but, whatever it may be called, it is of considerable magnitude in London. There are hundreds of such "hotels of the poor" scattered over the city every night, and surprising quantities of food are sold at them, much of it good and wholesome. One man in particular has an enviable reputation for the quality of his wares—a reputation he has earned by not only making his own pastry, but even roasting his own coffee. Some caterers own eight or nine stalls; and the extent of the piles of edibles and the oceans of coffee disposed of at the best of such conveniences may be gauged from the fact that the takings range from £4 to £8 per night. With a turnover of only £4 nightly, the profit is at least £12 per week.


STREET FLOWER-SELLERS.

Of late years many coffee stalls have changed hands for considerable sums, due in part to the value of the goodwill and in part to the extreme difficulty of making a "pitch" at the present time. In bygone days a man could take up a stand nearly anywhere; but now the police keep a sharp look out for squatters, and move them on long before they can acquire any vested interests, and thus the value of old "pitches" is enhanced.

Next to keeping a coffee stall, there is no more profitable street industry than newspaper selling, always provided that a good connection has been formed. Some of the well-known "pitches" in London streets must bring in their fortunate owners from £10 to £20 per week, and in a few exceptional cases even more.

But there is, it must be conceded, another side to the shield. Most of the men who sell some particular penny evening journal do not make eighteenpence per day, including the shilling that they receive as a sort of retaining fee. Given a bad "pitch," a vendor may not sell half-a-dozen of such sheets in a day. The great drawback to the trade is the number of "butterflies" who embark in it. During the school holidays swarms of youngsters take to newsvending for a brief spell, sometimes merely for pocket-money, at others to "help mother," but always to the detriment of the regular street agents.

Flower hawking, an industry peculiar in some respects to London, is carried on solely by girls and women. Like many other occupations, its form varies according to locality. At Islington, funeral wreaths are mainly sold; at Oxford Circus, big baskets of loose flowers are always on show; in Cheapside, buttonholes are obviously the mainstay of business; and so on at other recognised "pitches." Of course, the earnings vary accordingly. The most profitable branch of the trade is selling buttonholes, which enable a girl to make as much as 7s. or 8s. a day. The best customers are City men; the worst, ladies—they frequently demand so much for their money.

"SHOEBLACK."

For their stock flower-girls visit Covent Garden about 6 a.m. Making their purchases quickly, they usually go straight to their stands, and remain on them till they are sold out. Except on Saturday night, they try to avoid taking any flowers home, because they have nowhere to keep them, and would suffer loss in consequence. In this they are not always successful. But, in spite of this and other drawbacks, the majority of them make a moderate livelihood.

Of less prominent industries of the London streets a long catalogue might be drawn up. Among the food vendors are muffin makers, stewed-eel sellers, and the cooks who fry potatoes before your eyes. For the children there are balloons, flags, and windmills, and many other old favourites, for the most part home-made. The penurious are catered for by the dealer in old hats re-furbished to look like new. To minister to that common want, "a relish for tea," there are the hawkers of shrimps, winkles, and watercress.

But there is no end to London's street industries. They constitute an inexhaustible side of the great city, and are constantly increasing to meet public requirements or to exploit new ideas.

T. W. WILKINSON.

STREET NEWSPAPER STALL.

EVERYDAY LIFE IN THE ROYAL NAVY.

IN THE BARBER'S SHOP.
(Photo supplied by Miss Weston.)

THE bluejacket of to-day differs considerably from the "jolly tar" of Nelson's time. As far as bravery and handiness are concerned there is nothing to choose between our gallant seamen who fought at Trafalgar and those who, in default of seeing service on their proper element, checkmated the Boer gunners round Ladysmith and stormed the enemy's well-nigh impregnable position at Graspan; but socially there is a wide gulf between the two. The handy-man has long ceased to be the drunken, dissipated, improvident fellow his ancestor was; he is cleaner, thrifty, better educated, and a bit of a scientist to boot.

Service in the Royal Navy offers great attractions to well-behaved men and boys. It provides continuous employment at a good rate of pay up to the age of 50, and to that of 55 in certain ranks and ratings; and amongst other advantages, notably those of seeing the world under pleasant conditions and having a chance of acquiring distinction by zeal and gallantry, carries with it life pensions at expiration of service and employment in the Civil Service after being pensioned.

Boys are entered for training as seamen between the ages of 15¼ and 16¾. Every boy previous to being entered must satisfy the examining officers that he is of robust frame, intelligent, and of perfectly sound and healthy constitution, that he is able to read and write, and that his height and measure are sufficient. Again, every boy must bring with him a certificate of birth or a declaration from his parents and guardians that he is of proper age; also the consent in writing of his parents or guardians to his entering the Royal Navy and to his engaging to serve until he shall have completed twelve years' continuous service from the age of 18. It should be noted that boys who have been in prisons or reformatories are not received, while industrial school boys have to obtain the special permission of the Admiralty, which makes strict inquiry into their antecedents. Having passed the final medical examination

Photo C. Cozens, Southsea.

"BRITAIN'S MIGHT."

at a Naval Depôt, the candidate is sent to one of the harbour training ships, where he commences his career with the rating of a second-class boy and pay at 6d. per day, which his good conduct may increase. Whilst a boy is in the harbour training ship he is credited with £10 to enable him to provide

Photo: W. Gregory & Co., Strand.

SEMAPHORE SIGNALLING.

clothing and bedding. In course of time he becomes a first-class boy, and is sent to a sea-going training ship; and at 18 the boy becomes a man and is rated an ordinary seaman, receiving the sum of 1s. 3d. per day, which increases to 1s. 7d. when he becomes an able seaman. It is also possible, however, to enter the Royal Navy at a slightly later age—namely, as a youth between 16¾ and 18 years of age. These youths are entered for six months' training in a sea-going training ship, for the first three months as second-class boys; then, if their conduct has been satisfactory, as first-class boys. On completion of training, and attaining the age of 18, they are rated as ordinary seamen and drafted to the depôts for general service under the same rules and rates of pay as those who enter as boys in harbour training ships.

Men and boys supply their own outfit, towards the cost of which an allowance is made on entry and again on re-engaging. The kit of petty officers, seamen, artificers, stokers, boys, and all other ratings not specially provided for, comprises 1 monkey jacket, 1 jersey, 1 comforter, 2 pairs of serge and cloth trousers, 4 pairs of duck trousers, 2 serge and 3 duck jumpers, 2 jumpers with collar, 2 serge and 2 drill frocks, 2 check shirts, 3 flannels, 2 pairs of woollen drawers, 2 cholera belts, 3 Jean collars, 2 pairs of socks, 2 black silk handkerchiefs, 2 cloth caps, 1 sennet hat, 1 pair of half boots, 1 knife, 2 lanyards, 1 bed, 1 blanket, and 2 bed covers—to mention only the principal articles. The seaman keeps his papers and personal possessions in a specially provided receptacle known as a "Ditty Box."

Soon after he has attained the rating of ordinary seaman, the bluejacket undergoes a course at a gunnery school, either at Whale Island, Plymouth, or Sheerness; but a scheme has recently been matured for transferring a large proportion of the instruction in gunnery from the gunnery schools on land to the sea-going fleet, and for confining the further education in gunnery schools to those seamen who show special aptitude. Nevertheless, we must devote a few lines to the gunnery school at Whale Island, which is the most perfect in the world. Whale Island is a mud bank in Portsmouth Harbour, which has been reclaimed from desolation, and laid out with commodious officers' and men's quarters, gymnasiums, parade grounds, and an important edifice known as the "Battery." The last-named is a long, low building, fitted up so as to reproduce the conditions prevailing on board ship. Practically every type of naval ordnance will be found therein, grinning through port-hole or casemate at the open

water. Many of the guns are fitted with tubes, which enable them to fire miniature projectiles at targets representing ships, which are equipped with an ingenious mechanism causing them to roll about as ships roll on the waves. This instruction is also carried out at night, when the gun-sights are electrically illuminated. Out of doors, the seaman is practised in field-gun and machine-gun drill, rifle practice, and cutlass drill, and here, too, he learns all about ammunition and fuses. Further, he undergoes instruction in elementary fortification and rocket drill for saving life at sea. About 1,500 men are present at a gunnery school course, and at those held on Whale Island the men are most comfortably housed and fed, and allowed plenty of recreation.

A man leaves the gunnery school with a certificate as first- or second-class seaman gunner. A man with a first-class certificate may be further trained to qualify as a gunnery instructor, or he may volunteer for a torpedo course on board one of the torpedo school ships.

When a man has gained sufficient experience of a seaman's duties, and is a good helmsman, leadsman, etc., with a fair knowledge of gunnery, he is rated an able seaman, from which rating he may pass up to be leading seaman, petty officer, and chief petty officer. A man having been seven years at sea (one year of which as petty officer) is eligible for promotion to warrant officer, and to the commissioned ranks of chief gunner and chief boatswain, with pay varying from 5s. 6d. to 12s. a day. The rank of warrant officer is the highest which seamen can aspire to in the ordinary course of events; but those of exemplary conduct, who may distinguish themselves by acts of gallantry, are eligible to hold commissions, after undergoing an examination, in such rank or position as the Admiralty may deem them worthy to receive and competent to fill. Warrant officers, however, may retire with the honorary rank of lieutenant and a pension of £150 per annum.

Now let us briefly describe the bluejacket's life afloat. On the day a ship commissions, the ratings told off to her go on board from the depôt, and as each man is told off he receives a card, which tells him his exact place in his new domicile. From it he learns

Photo: W. Gregory & Co., Strand.

IN THE ENGINE ROOM OF H.M.S. *MAJESTIC*.

Photo. H. M. Cooke, Plymouth.

SWORD DRILL: ATTACK AND DEFENCE.

the watch and mess he belongs to, his place at the fire stations and in the boats, and his location for duty when the ship goes to quarters. It should be added that the men are divided into two watches, those on the left-hand side of the vessel being known as the Port watch, and those on the right-hand side as the Starboard. Nothing could be more perfect than the working of the marvellous mechanism that comes into force when one of His Majesty's ships hoists the pennant. From lower deck to bridge, every man knows his place, and what he has to do when he gets there. To the uninitiated the work may seem easy, simply because everything moves smoothly and well; but the fact of this smoothness and perfection implies that a vast amount of forethought and care has been exercised in advance.

When the stores and provisions and ammunition have been taken on board, the ship weighs anchor for the purpose of undergoing her steam trials, which proving satisfactory she departs for good to whatever part of the ocean the Admiralty has assigned to her. Every bluejacket is sent on foreign service for a period of three years.

Of course, the routine observed on board ship differs slightly according to the part of the world the latter may be in at the time, but the following description of a seaman's day afloat may be accepted as fairly representative: Work starts at 4 a.m., and the ship must be clean by 8 a.m. The cleaning process usually commences with "something with sand," and in fine weather "Jack" loves paddling about with a scrubbing-brush and hose in an inch or two of sand and water. Cleaning wood and brass-work with the bath-brick and emery paper follows, and every man takes a pride in trying to make his own little bit of brass brighter than those of others. The work of cleaning is punctuated by breakfast between 6.30 and 7 a.m., and at 8 a.m., or thereabouts, the guns come in for attention. At 8.30 a.m. the men parade in divisions and are inspected by the officers, while after "Divisions" come prayers. The latter being performed, the bluejacket has a little leisure, in which to enjoy a "relish" from the canteen and a whiff of his pipe; then he has to attend drills and exercises lasting till 11.30 a.m. At 12 (eight bells the bo'sun pipes to dinner, which consists either of 1 lb. of salt pork with split peas or 1 lb. of salt beef with flour, raisins, and suet, or preserved beef or mutton in lieu of the pudding materials. Every alternate day ¼ lb. of preserved potatoes or rice are issued, while there is also a weekly issue of 3 oz. of oatmeal and small quantities of mustard, pepper, salt, and vinegar. Grog is served out after dinner,

from a large tub inscribed with the loyal toast—"The King, God bless him!" The grog is prepared at 12.30, under the eyes of an officer, every man being entitled to half a pint, made up of 1 part rum to 3 parts water. Men not taking it receive instead a money allowance equal to 1¼d. every two days. Youngsters under 20 years of age are not allowed grog, and are known in consequence as "Nordenfelts."

From 1.15 to 3.30 p.m. there is more drill for one watch, the other going below meanwhile, and at 4.30 p.m. the decks are tidied, preparatory to supper, after which the men change into their night rigs and leisure follows. At 7.30 the crew "stand by hammocks," and at 8 p.m. the first watch muster. At 8.30 p.m. there is a final clean up, and fifteen minutes later the order "Out pipes and smoking lanterns" is given, and the Commander makes his nightly round. By 10 p.m. the crew of the floating fortress are sound asleep. Needless to say, there is a regular routine of "exercises." One day it is torpedo-net practice; another it is action or target practice, when everything is cleared away from the deck which could possibly interfere with the fire of the guns; another it is "Man and arm boats" for gun practice, the boats forming up in line abreast and firing with their 12-pr and 3-pr. quick-firers and Maxims at a target 500 yards away; and on another it is boat-sailing exercise, which training has a practical object, for landing parties can sail quicker than row, hence the former is always made use of when possible.

Thursday is "Make and mend clothes day," and is regarded as the bluejacket's half-holiday. Wherever, the wide world over, a British man-of-war may be, the usage is the same, and has been regularly observed ever since King William IV. in the the "twenties" of the last century, as Duke of Clarence and Lord High Admiral, first instituted the practice.

One or two details ought to be added before leaving the subject of the seaman's day. Breakfast and supper are made off an allowance of ¼ oz. tea, 1 oz. chocolate, 2 oz. sugar, and 1¼ lb. biscuit. In harbour, however, the seaman is allowed 1½ lb. of bread, ½ lb. vegetables, and, one day a week, 1 lb. of fresh beef or mutton. The messes are strictly divided. Among the officers, the captain has his meals alone, while the remainder of the commissioned ranks are divided between a wardroom and a gunroom mess. Then there is a warrant officers' mess;

Photo: W. M. Crockett, Plymouth.

AT DUMB-BELL EXERCISE.

while on the lower deck the chief petty officers, the stokers, and the able seamen are nicely divided.

Before passing on to other branches of the Service, it has to be noted in regard to the seaman class that a number of boys in the training ships are selected for the signal staff, and on being drafted to sea-going ships are rated signal boys, when, instead of rising to able seamen, they become in graduation qualified signalmen, yeomen of signals, and finally chief yeomen of signals. They are employed entirely on signals, and their paraphernalia consists of the "Big Dollond," flags, lamps, semaphore, and fog horn, which emits short and long grunts on the Morse code. Signalling is a most important subject, especially at fleet evolutions, when the signalmen are often knee-deep in flags.

Photo: W. Gregory & Co., Strand.
FIRING MACHINE GUNS.

The engineer department of the Navy is divided into engineer officers, artificers, and stokers.

Engineer officers enter this branch by competitive examination between the ages of 14 and 17, and go through a course of technical training, lasting four or five years, at the College at Keyham.

The engine-room artificers must be competent workmen — fitters, copper-smiths, boiler-makers, etc.— and can join the service, after passing an examination in the "three R's" and the practical management of steam engines and boilers, between the ages of 21 and 28. They are entered as chief petty officers, a position which carries with it many privileges. The pay on entry is 38s. 6d. per week, rising to 45s. 6d. after twelve years' service. After eight years' service they become eligible by examination for advancement to rating of chief engine-room artificer, at from 49s. to 52s. 6d. per week, while, when in charge of engines, they receive at least 7s. a week extra.

No previous experience is necessary to enter as a stoker, the age limit being 18 to 28. But simple as the operations of a stoker may be thought to be, it requires six to twelve months to develop him from a novice. His chief work is to trim coal and tend fires; he may, however, be ordered to take charge of such parts of the main or auxiliary engines as he is told off for. A second-class stoker, on entry, receives 11s. 8d. per week, and can rise to 35s. per week as chief stoker. Extra pay is given when serving in torpedo boats and destroyers, and when in the tropics.

The port-main engine room of a war-ship is a wonderful sight, but the layman cannot possibly comprehend the labyrinth of pipes and levers, and the whirring, whirling rods and shafts, which spatter the walls with milk-white grease, and almost deafen with their pounding and throbbing.

The boiler room of a war-vessel is a veritable pandemonium and inferno combined. The din of the engine room is as nothing

compared to the din here, while the temperature is often as high as 140° Fahr. A gale of hot wind rages in this—the bowels of the ship—and causes the coal dust to fly about and whip the face like hail. In front of each boiler—and our latest cruisers carry thirty boilers in four great rooms—stands a black, begrimed sentinel, waiting till it is his turn to open the furnace door and shovel fuel into the roaring element; for a regular routine of firing is observed. At each side of the room are the coal bunkers, where the trimmers, by the dim light of Davy lamps, are working like demons, filling up the trollies, and skilfully avoiding the falling masses occasioned by the lurching of the vessel.

If a man does not join the Royal Navy either as a bluejacket or stoker, he may volunteer for armourer, blacksmith, carpenter, cooper, painter, plumber, sailmaker, shipwright, sick berth staff, or domestic, full particulars concerning the qualifications for which may be obtained from any recruiting station or post office.

Last, but not least, there are the Royal Marines, which *corps d'élite* forms a portion of the Naval forces of the country, although they are in every sense sailors, while their motto "*Per mare, per terram*" aptly describes the nature of their duties. The Royal Marines are divided into two corps, Artillery and Light Infantry; the former have their headquarters at Eastney, while the latter are grouped in three divisions at Portsmouth, Plymouth and Chatham. The depôt is at Walmer, where all recruits join and are trained pretty thoroughly before joining their divisions, the course lasting about a year and including instruction in gunnery. As a rule, more than one-half of this force is embarked for duty on His Majesty's vessels. When serving on board ship the marines are employed as sentries, and keep regular watch like the bluejackets, and when not on guard assist in all the duties of the ship except going aloft. In action, the men of both the Marine Artillery and Light Infantry are stationed at the guns conjointly with the seamen gunners, those not so employed being used as a rifle party on deck. The marines form part of all Naval brigades landed for

Photo: Russell & Sons, Southsea.

A ROOM IN THE NAVAL BARRACKS, WHALE ISLAND, PORTSMOUTH.

service on shore. This splendid corps, which is recruited like the Navy under the long service system, offers great attractions to lads having a liking for soldiering combined with service afloat.

In conclusion, it is no exaggeration to state that there is no other service which offers such advantages as the Royal Navy, promotion being exceptionally rapid in the case of well-conducted and intelligent men who are determined to get on; while, in almost all cases, large additional pay or wages, and, in certain circumstances, liberal allowances may be drawn for special services and qualifications. After twenty-two years' service pensions are awarded on a generous scale; but men disabled or invalided from the service are also eligible to receive them. Whilst men and boys have a chance of visiting all parts of the world in His Majesty's ships, care is taken that, as far as practicable, all shall have a fair proportion of home service. Both at home and abroad leave is granted without deduction of pay, and on return from a commission abroad as much as six or eight weeks' leave is granted. The Marines' headquarters are permanent, and men enjoy the privilege of always returning to the same barrack, which is their service home.

H. G. ARCHER.

Photo: Gregory & Co., Strand.

BLUEJACKETS IN SUMMER DRESS.

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